SYSTEMATICS OF THE FAMILIES MITRIDAE & VOLUTOMITRIDAE

(MOLLUSCA: GASTROPODA)

BY

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SYSTEMATICS OF THE FAMILIES MITRIDAE AND VOLUTOMITRIDAE

I. INTRODUCTION

In this study of the rachiglossate gastropod families Mitridae and Volutomitridae, an attempt is made to evaluate the taxonomic acceptability of genus groups proposed for the 950 fossil and recent species of both families. A supraspecific arrangement acceptable to both the malacologist and paleontologist is not only desirable, but imperative, when both disciplines deal with molluscan populations separated only in time. This aim cannot be achieved without compromise, and modifications had to be effected in order to present a more logical, if not definite, subfamilial and generic arrangement acceptable to students of both disciplines.

ABBREVIATIONS AND METHODS

Abbreviations of type species designations and classification of zoological names follow the standard of the *Treatise on Invertebrate Paleontology* (Moore *et al.*, 1960). The characteristic species included in the appropriate genera and subgenera are species which we believe to be assignable to these groups according to our present-day knowledge. The radulae of some indicator species and some type species still remain unknown, and a subsequent re-assignment of some species at a future date may become necessary. Bracketing of author's names in the listing of characteristic species has been omitted in order to eliminate several hundred brackets. The examination of original types necessitated several, as yet unpublished revisions and name changes; it was found advisable to add a bracketed synonymy for ease of clarification as to the identity of the species concerned. The term "Eastern Pacific" is used for the faunal province extending from California to the west coast of Panama, to the Galápagos Islands and Peru. The indication "Caribbean" for fossil records is the Tertiary Caribbean region as defined by Woodring (1966), including Florida and Northern South America.

Abbreviations of names of Institutions are as follows:

AIM = Auckland Institute and Museum, Auckland, N.Z.

AM = Australian Museum, Sydney, Australia.

AMNH = American Museum of Natural History, New York, U.S.A.

ANSP = Academy of Natural Sciences, Philadelphia, U.S.A.

BMNH = British Museum (Natural History), London, England.

CM = Canterbury Museum, Christchurch, N.Z.

DM = Dominion Museum, Wellington, N.Z.

IRSN = Institut Royal des Sciences Naturelles, Brussels, Belgium.

LS = Linnean Society, London, England.

MCZ = Museum of Comparative Zoology, Harvard University, Cambridge, U.S.A.

MHNG = Muséum d'Histoire Naturelle, Geneva, Switzerland.

NMW = National Museum of Wales, Cardiff, England.

NZGS = New Zealand Geological Survey, Lower Hutt, N.Z.

USNM = United States National Museum, Washington, U.S.A.

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II. FAMILY MITRIDAE

For the purpose of this study, all available type species of genera were examined, and in addition, the types of over 800 species were measured and recorded in colour for reference. Close to 150,000 specimens of Mitridae contained in collections of major Museums and Institutions were examined, and *c.* 8000 living specimens of half the known species were collected by the author on tropical reefs. All available literature on the subject has been consulted, and 2,624 specific names proposed for Mitridae alone were recorded. It is evident that new taxa published in obscure Journals and tracts may have been overlooked, but omissions would not exceed 5% of all taxa recorded. Species which have been only briefly diagnosed and never illustrated, will necessarily remain *nomina dubia* pending a future discovery of the types, in which event changes and revision of the specific concept are to be anticipated.

The classification proposed in this study will either supersede or supplement the arrangement currently in preparation for the *Treatise on Invertebrate Paleontology,* where important changes in generic concepts have not been incorporated.

HISTORICAL SUMMARY AND CHOICE OF CRITERIA

The Linnaean species of Mitridae were originally contained in the Linnaean genus *Voluta,* with the exception of one species, which was assigned to *Buccinum.* Röding (1798), proposed the genera *Mitra, Vexillum* and *Pterygia,* and Swainson (1831) added *Tiara* and *Mitrella* (= *Swainsonia* H. & A. Adams). At about this time, Mitridae were removed from the Volutidae and accorded familial rank. The first monographic treatment of the Mitridae compiled by Lamarck (1811, 1822), was descriptive, but lacked illustrations. A fully illustrated monograph of the family was produced by Kiener (1838-1839), and was shortly afterwards followed by the monographs of Küster (1838-1841), Reeve (1844-1845), Sowerby (1874) and Tryon (1882). Tryon's monograph, the last ever written on world-wide Mitridae, has lost much of its usefulness through indiscriminate lumping of unrelated species and indifferent copies of illustrations.

The tentative generic arrangement proposed by the writer in 1966 was biased in favour of living forms, and incomplete without extinct groups of species. Coan's review of the Mitridae (1966) in preparation for the *Treatise on Invertebrate Paleontology* was actually only an enumeration of nomenclatural units of Mitridae, containing also 17 non-mitrid generic units.

The total number of specific names proposed, and evaluation as to their validity as biospecies is shown in Table 1. The number of tentatively valid fossil species appears unproportionately high in comparison with the number of currently accepted Recent species. A reduction in the number of fossil

TABLE 1

TAXONOMIC STATUS OF PROPOSED BINOMIAL TAXA IN THE FAMILY MITRIDAE

SPECIES	RECENT	FOSSIL	TOTAL
Primary and secondary homonyms	162	130	292
Objective and subjective synonyms	691	321	1,012
Nomina dubia	134	66	200
Non mitrid taxa	75	201	276
Suppressed names and nomina oblita	6	—	6
Tentatively valid names	377	461	838
Total number of proposed names	1,445	1,179	2,624

1888) Italian Mio-Pliocene "species" will require particular attention in view of the great number of named variants. It is doubtful that the Tertiary Caribbean province really supported so many described *Cancilla-Subcancilla* species, and the great number of *Costellaria* "species" of the *V.(C.) wandoense* (Holmes) complex.

Thiele (1929) arranged the living species of Mitridae in 5 genera, 4 subgenera and 14 sections, a total of 23 units in all. Wenz (1943) treated both fossil and Recent species, and his arrangement contained 11 genera and 24 subgenera, a total of 35 generic units, non-mitrid genus-groups excluded. In this study, the 838 fossil and Recent species of Mitridae have been assigned to 17 genera and 11 subgenera, a total of 28 generic units or *c.* 30 species per genus group; 4 genera and 3 subgenera contain fossil species only.

A generic subdivision of the family based purely on conchological or anatomical characters must inevitably differ from an arrangement based on shell, radula, anatomy, ecology, distribution and phylogeny. Shell-characters may be well-defined in species-groups such as *Dibaphus, Thala* and *Zierliana,* but are less clear cut in closely related genera or subgenera such as *Vexillum-Costellaria, Costellaria-Pusia* and *Mitra-Nebularia.* Radulae in some genus groups may differ greatly in pattern species is to be expected once the type specimens are examined and re-evaluated. Bellardi's (1887- from species of another related group, in which case separation is easily achieved through radula examination. In the vexilline genera *Vexillum, Costellaria* and *Pusia,* correct subgeneric placing may prove difficult at times, in view of undefined, gradually changing characters and the great number of transitional species. Matters are further complicated by the presence of a vexilline radula in *Pusia* species (e.g., *V.(P.) cancellarioides* and *V.(C.) luculentum*), and a Pusiine radula in *Vexillum* species (*V.isaoi*).

In genera which show distinct but closely related and little modified sub-groupings, the erection of subgenera is quite desirable; to raise a group from subgeneric to generic rank simply because it is a large one, loses sight of the meaning of categorical rank. The *Vexillum-Costellaria-Pusia* groups are a case in point; species are indeed numerous, but the group does not lend itself readily to further subdivisions on the basis of any tangible evidence, morphological or anatomical. *Vexillum(Pusia) ebenus* (Lamarck), a moderately common Mediterranean-East Atlantic species, will develop ecophenotypic and individual variants which reflect affinities representative of several mitrid groups. The typical form (Plate 9, fig. 13), has the features of *Pusia* and to a lesser extent *Mitra,* while the slender, elegantly costate form (Plate 9, fig. 14) could easily be classed as a *Costellaria*; the broad inflated barrel-shaped variant (Plate 9, fig. 15) shows close affinities to the tropical *Idiochila* type of *Pusia.* The radula of *V.(C.) ebenus* is Pusiine, with a tricuspid rachidian.

SHELL MORPHOLOGY

Variation in colour, form and sculpture is more pronounced in species of Mitridae than any other rachiglossate prosobranchs. In the Mitridae, almost two thirds of the existing synonyms owe their origin to an underestimation of individual variation. Malacologists place too much reliance in the colour of the shell, and not infrequently use this particular character for diagnostic purposes. Paleontologists, on the other hand, often fail to recognize apparent differences between specimens of a species as the transitional developmental stages of that particular form; the limits of variation within species are usually not anticipated by the paleontologist. The value of diagnostic characters and their application in species differentiation of Mitridae and Volutomitridae is discussed.

Form: In the majority of Mitridae and Volutomitridae, broad and slender forms occur within the same species; the width ratio, expressed in per cent of shell length, gives a reliable indication as to the limits of width fluctuation. Juvenile and immature specimens are always broader than adults, and obesity decreases with maturity (Plate 8, figs. 11, 12).

Whorls: The number of fully formed, mature whorls may vary by as many as 4 whorls in adult shells, while nuclear whorls will vary by 2 at most. In juvenile shells, nuclear whorls are more numerous and fully formed whorls less numerous than in adult shells. In vexilline species with generally convex whorls, the development of sub-angulate or angulate whorls is not at all unusual.

Aperture: The relative length of the aperture in relation to the total length of the shell is not a constant factor; short or long apertures are encountered in individuals of the same species (Plate 1, figs, 4, 5). The aperture is always wider in juvenile shells, and becomes more restricted with maturity.

Labial lip: Species with crenulations over the entire length of the lip never produce individuals with a smooth lip, and vice versa. In species where crenulations are confined to the ultimate half or one-third of the labial lip, denticles may at times become obsolete through an overlay of enamel. In juvenile shells, the labial lip is thin, convex and unformed. (Plate 3, fig. 10).

Sculpture: This character is more prone to variation than generally anticipated. In species of Mitrinae with smooth or obsoletely striate shells, a sculpture of deep grooves or pits may develop in some individuals (Plate 1, fig. 5). In the Vexillinae, the number of axial ribs may reach three times the minimum number recorded (e.g., *Vexillum*(*Costellaria*) *acupictum*—axial ribs on the body whorl vary from 16 - 47). Axial ribs may vanish completely on the body whorl in species which are normally entirely costate (e.g., *V.curviliratum* Sowerby, *V.vulpecula* Linnaeus, *V.*(*C.*) *semisculptum* Adams & Reeve, etc.). Spiral sculpture consisting of striae, cords or pits is also subject to variation. In some specimens of a species spiral threads may be confined to the interstices where they form deep grooves; in some individuals, however, the spiral threads will override the axial sculpture and nodules may appear at the point of intersection. The number of axial ribs or spiral striae in the Vexillinae neither increases nor decreases with maturity. In Mitrinae, however, whatever sculpture is present may become obsolete in gerontic individuals. In the Imbricariine groups like *Cancilla, Subcancilla* and *Domiporta,* the appearance of intermediate secondary spiral cords is sporadic and purely accidental, and not an inherited specific trait.

Labral lirae: Labral lirae are present in adult species of all vexilline genera, with the exception of the temperate water genus *Austromitra*; the development of labral lirae in species of *Austromitra* is erratic, and rather similar to the volutomitrid genera *Microvoluta* and *Conomitra.* Rarely are labral lirae developed in juveniles; but with increasing maturity, lirae become more numerous and prominent. In the species *Zierliana oleacea* (Reeve), labral lirae are at times covered with a layer of enamel. The number of labral lirae in Vexillinae is subject to fluctuation. The "pseudo-lirae" which sometimes appear in Mitrinae species should not be confused with labral lirae; these are a duplication of the spiral sculpture impressed on the labral wall.

Columellar folds: The assumption, that the number of columellar folds is constant in Mitridae species, has been responsible for the creation of several synonyms. The number of folds actually vary by ± 1 fold from the mean number, or up to 3 folds in individuals of a species; only in exceptional instances will the number of folds vary by 4 in any one species. In adults, the columellar folds are generally thickened and well developed, with the first posterior fold the largest and the last anterior fold being the smallest; folds are generally obliquely oriented, with the exception of the first posterior fold which may at times be at right angles to the axis of the shell. In juvenile specimens, the columellar folds are sharper, more elevated and sometimes more distant than in adults. In the Vexillinae, the number of columellar folds neither increases nor decreases with maturity.

Colour: The colour pattern in the Vexillinae, and to some extent in the Imbricariinae, is highly variable within species, but appears to be less so in the Mitrinae and Cylindromitrinae. In a moderately large series of the common *Vexillum vulpecula* (Linnaeus), one may observe specimens which are uniformly blackish-brown, tan, orange, yellow, cream or white, or banded in various colours. As in the families Conidae, Muricidae and Cypraeidae, albinotic specimens have been recorded in several species of Mitridae; all but one of these albino specimens have been described as new species. In some *Subcancilla* species, specimens may be uniformly cream or brown, while others are prominently maculated and have spiral cords lined with golden-brown.

The degree of variation within a species is reflected by the number of synonyms bestowed upon a biospecies. The four species of Mitridae living in the Mediterranean and East Atlantic region have received no fewer than 76 specific and varietal names. The variable species *Vexillum*(*Pusia*)*ebenus* (Lamarck), in its various smooth, costate, slender and broad forms, has received 38 names; if the Pliocene taxa proposed for this species are taken into consideration, over 100 names for one species alone would be recorded in literature. The creation of synonyms is a relatively simple matter, but their elimination a difficult, complicated and often time-consuming task. The accumulation of synonyms in Mollusca, particularly in the Mitridae, is rising at an alarming rate through descriptions of solitary

atypical specimens, ecophenotypic and individual variants, beach-worn shells and juvenile examples; ignorance of chronological priorities and misapplication of taxonomic procedures contribute their share of synonyms.

ANATOMY

Vayssière (1901) and Risbec (1955), reported on the anatomy of the Mitridae, and both authors reported the presence of a "venom gland". The presence of this particular "venom gland" (Figs. 1-2),

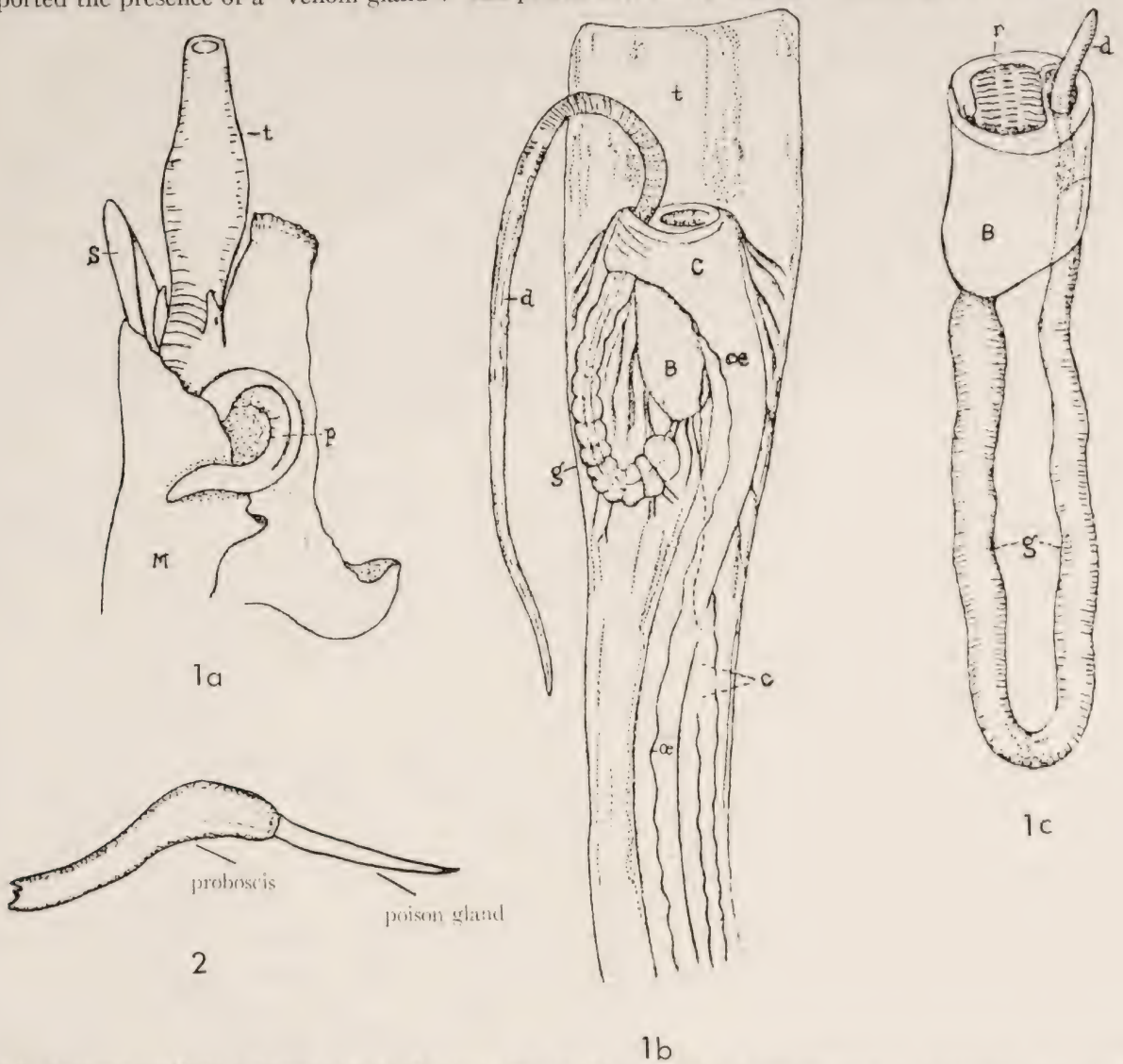


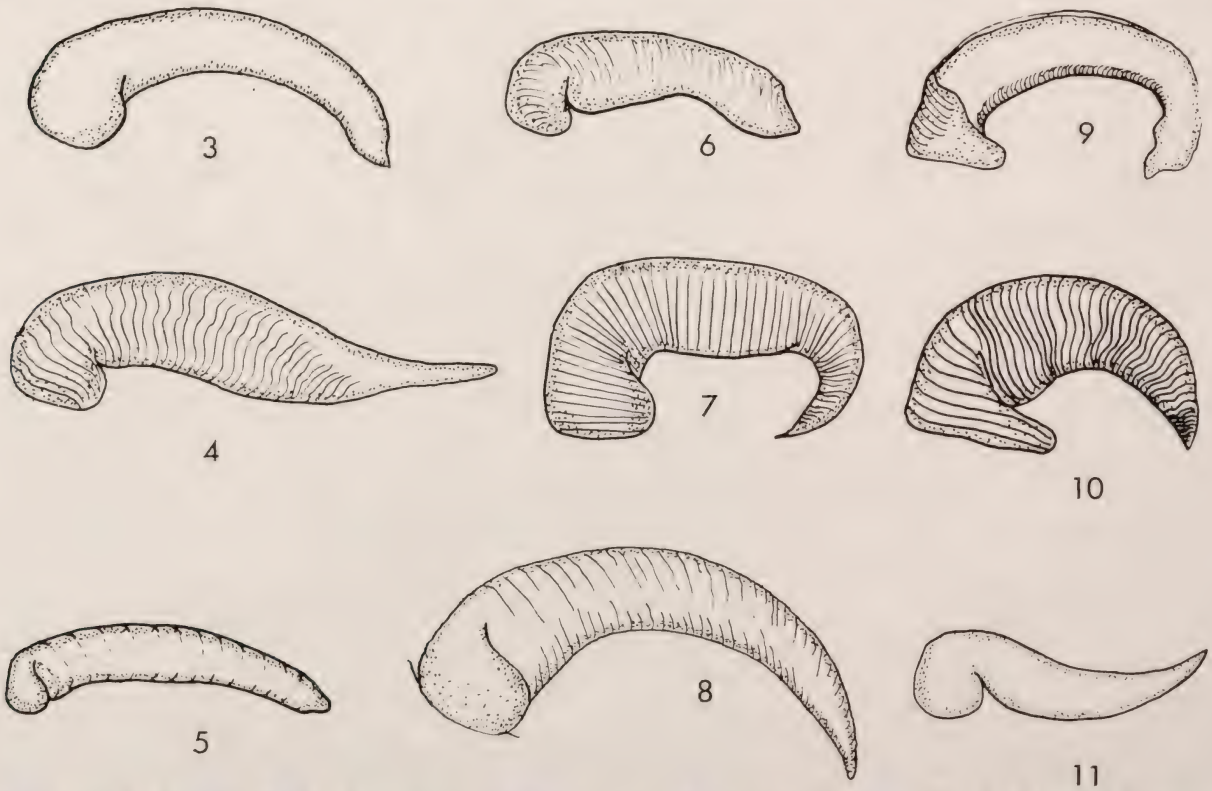
Fig 1. Anatomy of *Mitra fusiformis zonata* Marryat. Fig. 1a. M = mantle; S = siphon; t = proboscis; p = penis. Fig. 1b. t = proboscis; B = buccal bulb; d = protractile venom gland; g = venom gland sheath; C = tissue enclosing buccal bulb; oe = oesophagal nerve; c = cerebro-buccal glands (buccal ganglia hidden by oesophagus). Fig. 1c. d = venom gland enclosed in sheath; r = radula; B = buccal bulb (all figures 6x) (After Vayssière, 1901, pl. 3). Fig. 2. *Neocancilla clathrus* (Gmelin). Proboscis with poison gland in extended position.

which Vayssière presumed to be some sort of tactile or exploratory organ, has now been confirmed in the subfamilies Mitrinae, Imbricariinae and Vexillinae. The venom, provided it is a venom in the strict sense of the word, has not been subject to toxicological tests, but personal observations have made it clear that the venom gland is used for killing prey.

Risbec (1955) suggested wide-sweeping changes in supra-generic classification on the basis of the presence of aberrant and homologous organs in some species of Mitridae. The conclusions drawn by this author were based on evidence of only 2% of all known living species, and some of the material under Risbec's scrutiny was misidentified, and in one case possibly not even mitrid. Risbec's suggestion was the removal of the Mitridae (subfamily Mitrinae only) to the Toxoglossa, on the grounds

that Mitrinae possess a venom gland. Following Risbec's reasoning to its logical conclusion, 3 of the mitrid subfamilies would be transferred to the Toxoglossa, and the rachiglossate genus *Marginella* would have to accompany them. Graham (1966) found a poison gland, resembling the poison gland of the toxoglossans, in the volutacean genus *Marginella*. Risbec also failed to mention the appropriate allocation for Mitridae which lack a poison gland. The vexilline subgenus *Pusia* was removed by Risbec to the Purpuridae (= Thaidinae in Muricidae) and some vexilline species such as "*V.luculentum* Reeve" and "*V.hebes* Reeve" were assigned to the operculate Nassidae (= Nassariidae). The species "*Mitra(Vexillum)luculenta* Reeve" was reported by Risbec to be common on rocks on the coast of New Caledonia, and *Engina reevei* Tryon and *Cantharus menkeanus* Dunker, were suggested as possible synonyms of *V.luculentum*, which had an anatomy similar to the Nassidae (= Nassariidae). It is suspected that the "*M.luculenta*" of Risbec was the buccinid species *Engina mendicaria* Linnaeus, a species superficially resembling *V.(P.)luculentum* (Reeve) and common on rocky shores of New Caledonia; the two probable synonyms cited by Risbec are Buccinidae. "*Mitra(Vexillum)hebes*" of Risbec was certainly misidentified, as the real *M.hebes* Reeve is a *Neocancilla* endemic to the coasts of West Africa and the Island of St. Helena. Fleming (1958) also remarked on Risbec's misidentification of species used in his anatomical study.

Marcus & Marcus (1959) found the present grouping of rachiglossate prosobranchs in the superfamilies Volutacea, Muricacea and Buccinacea to be somewhat artificial. This indeed may be the case, provided that such a grouping would be based on homologous affinities or differences within the prosobranch groups. The close relationship of rachiglossate prosobranchs is clearly demonstrated by the sporadic occurrence of organs resembling other Rachiglossa in the Prosobranchia. According to Marcus & Marcus (loc. cit.), in the volutacean genera *Oliva* and *Olivancillaria* the oesophagus is muricacean in arrangement, while Graham (loc. cit.) found a muricacean oesophagal structure in Volutidae. Marginellidae and Mitridae have a poison gland besides paired salivary glands, and *Cancellaria* has 2 pairs of salivary glands and a gut which conforms to neither pattern (Graham, 1966). In the Volutidae, different nervous systems are found in one and the same subfamily, and sometimes within the same genus; features of the nerve-ring in the Olividae is reminiscent of the Buccinacea (Marcus & Marcus, 1966). A molluscan classification based on the apparent similarity of individual



Male penes of Mitridae. Fig. 3. *Mitra mitra* (Linnaeus). Fig. 4 *M.carbonaria* Swainson. Fig. 5. *M.(Strigatella) retusa* Lamarck. Fig. 6. *Neocancilla papilio* (Link). Fig. 7. *Pterygia scabricula* (Linnaeus). Fig. 8. *Vexillum (Costellaria) sanguisugum* (Linnaeus). Fig. 9. *Ziba bacillum* (Lamarck). Fig. 10. *Scabricola (Swainsonia) fissurata* (Lamarck). Fig. 11. *Vexillum (Costellaria) semifasciatum* (Lamarck).

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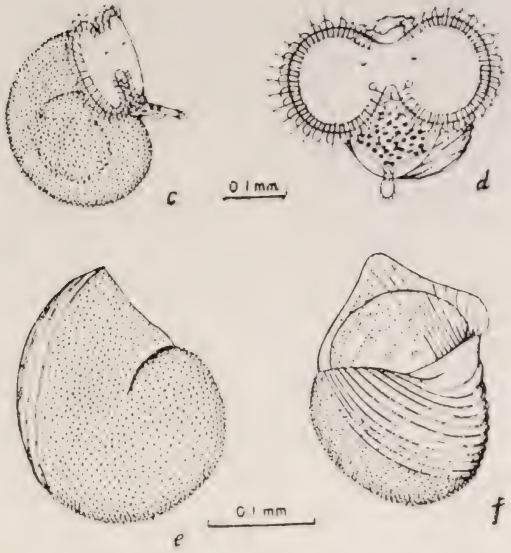

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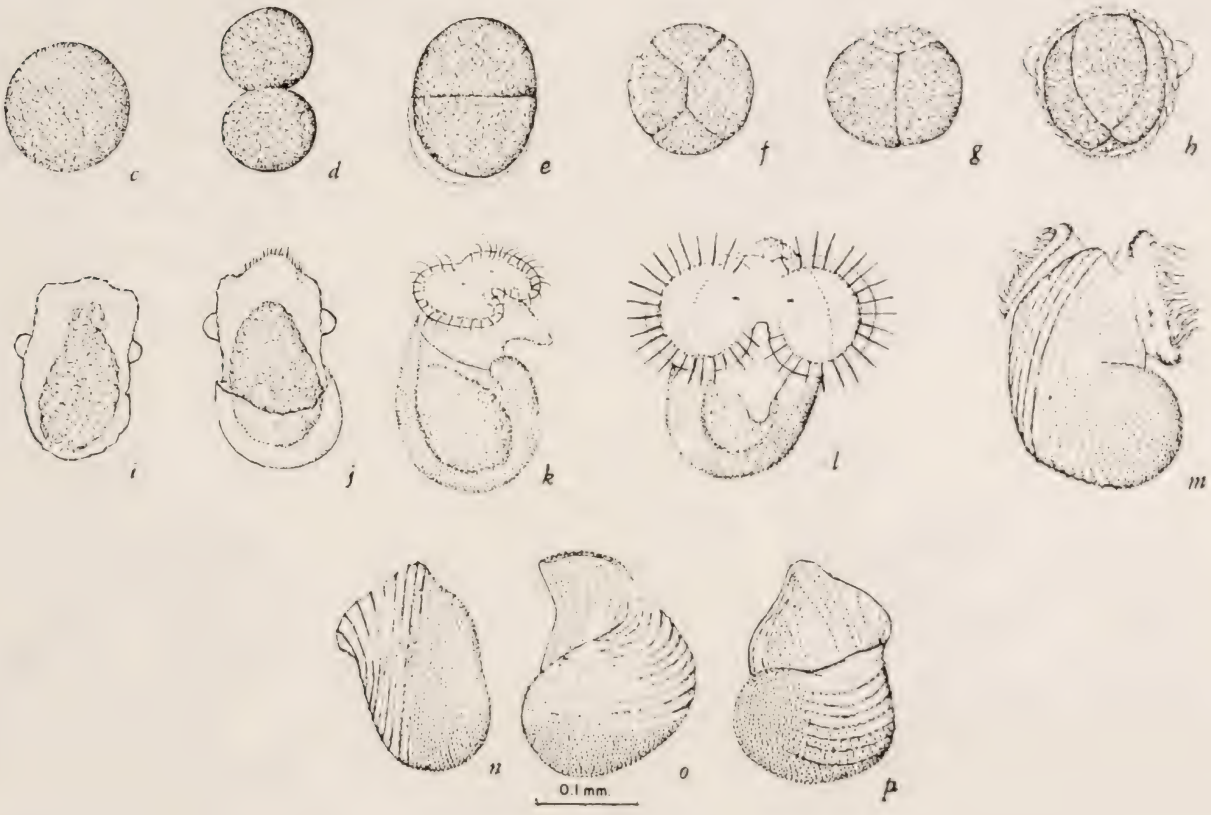

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Egg capsules and development. Fig. 12. Egg capsules with embryos in veliger stage of *Mitra* (*Strigatella*) *auriculoides* Reeve, from the Hawaiian Islands. Fig. 12a. c-d, free-swimming veliger; e-f, shell of free swimming veliger. Fig. 13. Egg capsule of *Mitra* (*Strigatella*) *pellisserpentis astricta* Reeve, from the Hawaiian Islands. Fig. 13a. c-g, cleavage stages; h, blastula stage; i, gastrula stage; j, embryo showing rudiment of shell; k, veliger; l, ventral aspect of free-swimming veliger; m, dorsal aspect of free-swimming veliger; n-p, shell of free-swimming veliger larva. (After Ostergaard, 1950, figs. 8-9).

organs among the prosobranch groups, and on only a small percentage of living species, would seriously upset existing molluscan taxonomy. Any major re-classification of rachiglossate prosobranchs on anatomical grounds should be delayed until at least half of the known living species in each group have been examined. Thiele (1929) advocated anatomical examination of many more species of Mitridae before re-arrangement of supra-generic groups. In view of the sporadic occurrence of similar organ arrangement within prosobranch groups, and misidentification of species examined by Risbec, this author's re-classification of the Mitridae into Toxoglossa, Muricidae and Nassariidae is not acceptable.

For penal appendages, see Figs. 3 - 11. Spawns, development and egg-capsules of Mitridae (Figs. 12 - 18) have been described or figured by Ostergaard (1950), Cernohorsky (1966), J. Cate (1968) and Wolfson (1969); for mating behavious of *Mitra* in captivity, see J. Cate (1968).

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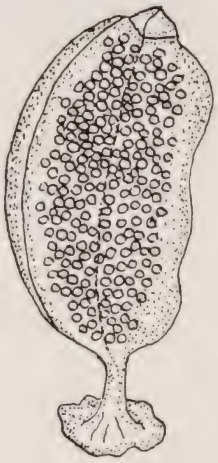

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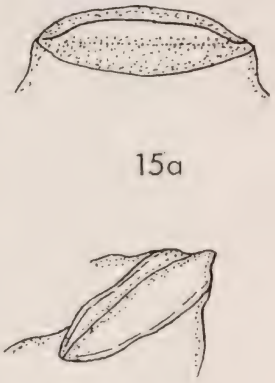

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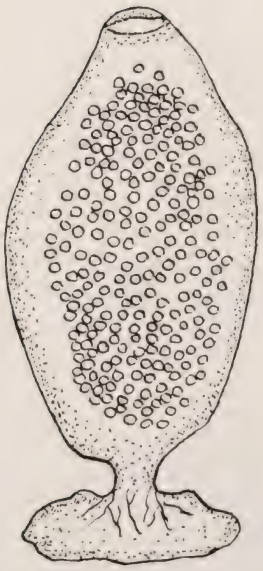

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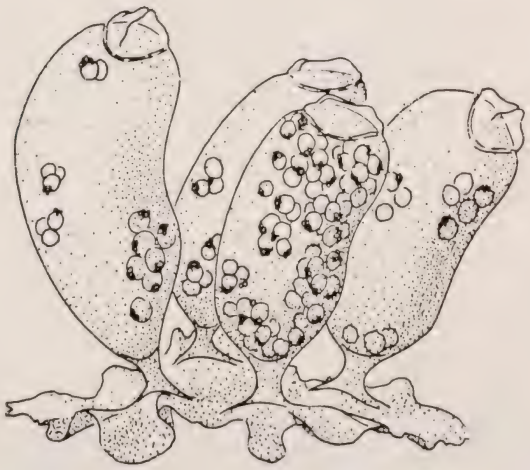

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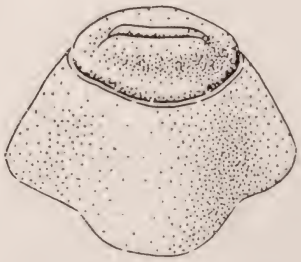


18a

Egg capsules. Fig. 14. *Mitra idae* Melvill, Mission Point, California (After J. Cate, 1968a, textfigure 8). Fig. 15. *Mitra* (*Strigatella*) *paupercula* (Linnaeus), Nakuna, Okinawa. Fig. 15a. Side view of escape hatch on dorsum of egg capsule. Fig. 15b. Latero-dorsal view of same. Fig. 16. *Cancilla* (*Domiporta*) *filaris* (Linnaeus), Mauritius. Fig. 17. *Ziba flammea* (Quoy & Gaimard), Mauritius. Fig. 18. *Mitra* (*Strigatella*) *tristis* Broderip, Bahía de los Angeles, Mexico. Fig. 18a. Top view of capsule (After Wolfson, 1969, figs. 1-2, as *Mitra dolorosa* Dall).

THE RADULA

The interpretation of radulae of prosobranch gastropods has proved an invaluable aid in supra-specific classification and evaluation of relationships within groups of families. Cooke (1920) remarked on the superior value of lateral teeth in estimating the relationship of allied groups and species of Mitridae. Cooke's statement is indeed applicable to three out of four subfamilies of Mitridae, but not to species of Vexillinae, where laterals are simple and sickle-shaped in all genera. In the other subfamilies, the pattern of the rachidians is variable, and of little or no value in classification. The diverse radula patterns of the Mitridae (Figs. 19 - 156) reflect phylogeny combined with the species' ecological niche, rather than feeding habits alone as suggested by some writers. The radula, as used in molluscan classification, particularly in the Mitridae, is of great value in the elucidation of subfamilial and generic relationships, but of minimal value in species differentiation; the exceptions are very similar

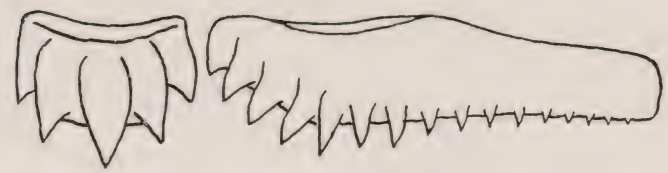
TABLE 2

CORRELATION CHART OF MITRID RADULAE

GENUS-GROUP	Width of radula in % of ribbon length	Length of radula in % of shell length	No. of rows of teeth per 1mm ribbon length	No. of rows of teeth per 10mm of shell length	Ratio Rachidians:laterals
Mitra	9% — 37%	6% — 21% (10%)	5 — 106	5 — 93	1:1.75 — 1:4
Pterygia	4% — 6%	3% — 7% (5%)	60 — 65	19 — 46	—
"Ziba"	16% — 23%	6% — 15% (11%)	11 — 121	16 — 46	1:1.5 — 1:2.75
(*Domiporta*)	13% — 18%	3% — 6% (4%)	57 — 190	25 — 67	1:1.1 — 1:1.75
Neocancilla	10% — 14%	6% — 14% (11%)	12 — 38	14 — 44	1:1.5 — 1:1.7
Scabricola	11% — 16%	13% — 21% (17%)	9 — 25	15 — 33	1:1 — 1:1.5
Imbricaria	14% — 24%	6% — 14% (11%)	18 — 44	20 — 30	1:1.5 — 1:2
Vexillum	8% — 23%	3% — 7% (5%)	29 — 150	15 — 63	1.25:1 — 2.5:1
Zierliana	20% — 25%	7% — 10% (9%)	23 — 31	16 — 30	1.5:1 — 2.0:1

species with different radulae features. There is a distinct correlation of width : length ratio of the odontophore, radula-length: shell-length and ratio of rachidians : laterals in the various mitrid genera (Table 2).

Results of radula studies of Mitridae may be found in the works of Troschel (1866-1893), Schepman (1913), Cooke (1920), Peile (1922, 1936, 1937, 1938), Thiele (1929), Habe (1934), Barnard (1959), Cernohorsky (1965, 1966) and J. Cate (1967).



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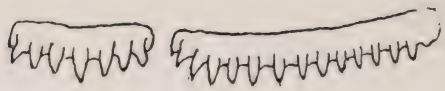

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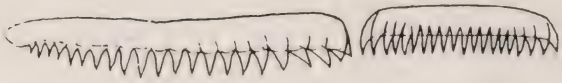

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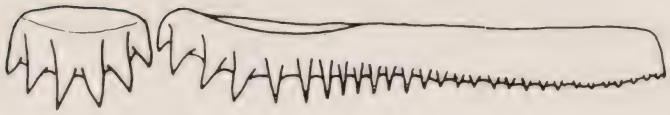

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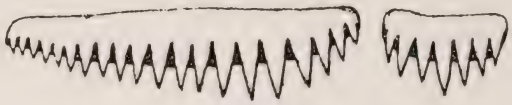

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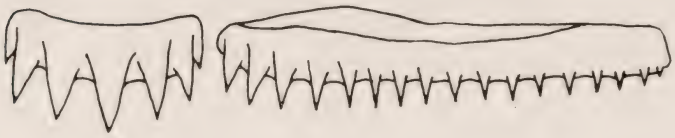

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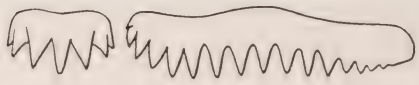

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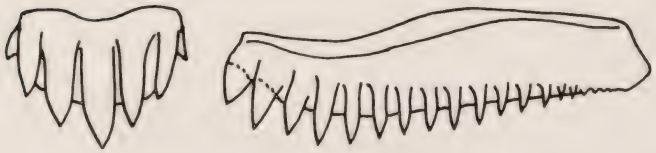

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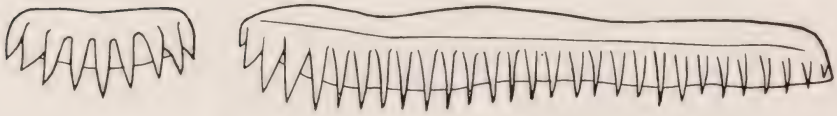

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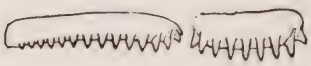

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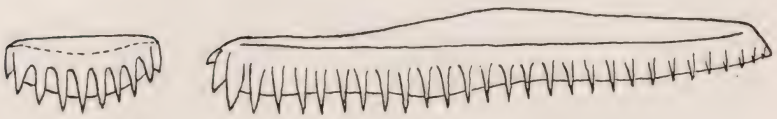

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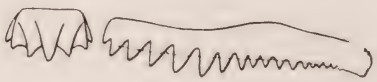

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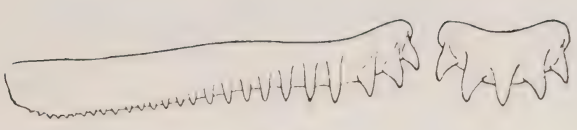
Radulae (half a row) of Mitridae. Fig. 19. *Mitra mitra* (Linnaeus), Fiji Islands, intertidal. Fig. 10. *M.stictica* (Link), Fiji Islands, intertidal. Fig. 21. *M.cardinalis* (Gmelin), Fiji Islands, intertidal. Fig. 22. *M.incompta* (Lightfoot), off Barber's Point, Oahu, Hawaiian Islands, in 10 fathoms (18 metres). Fig. 23. *M.imperialis* Röding, Fiji Islands, intertidal. Fig. 24. *M.coffea* Schubert & Wagner, Fiji Islands, intertidal. Fig. 25. *M.solida* Reeve, Twofold Bay, N.S.W., Australia (after Peile, 1922b, fig. 1). Fig. 26. *M.sigillata* Azuma, Enshu-nada, Atsumi Peninsula, Japan, in 50 fathoms (92 metres) (after Azuma, 1965, fig. 7). Fig. 27. *M.fusiformis zonata* Marryat, Mediterranean (after Vayssière, 1901, pl. 3, fig. 5). Fig. 28. *M.cornicula* (Linnaeus), Messina, Mediterranean (after Troschel, 1867, pl. 6, fig. 5 — as *M.cornea*). Fig. 29. *Mitra(Dibaphimitra)florida* Gould, off Fisher I., Florida, in 13 fathoms (24 metres) (after Bayer, 1942, pl. 7, fig. 3). Fig. 30. *M.bovei* Kiener, Suez (after Cooke, 1920, fig. 15). Fig. 31. *M.nigra* (Gmelin), Madeira (after Troschel, 1867, pl. 6, fig. 6 — as *M.fusca* "Reeve").



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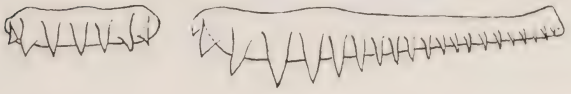

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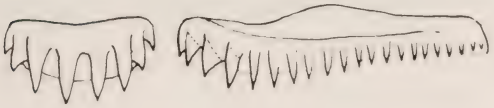

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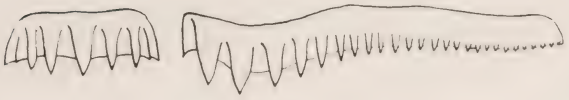

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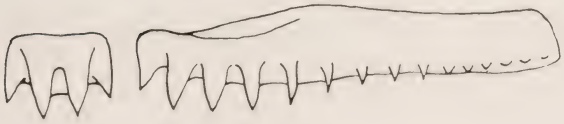

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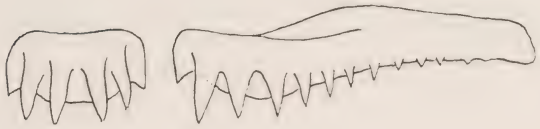

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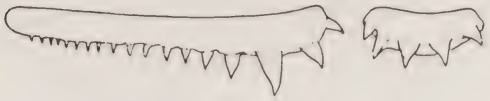

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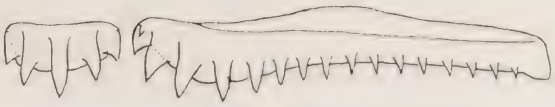

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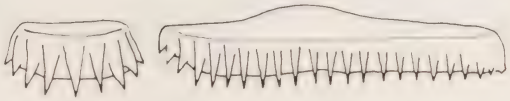

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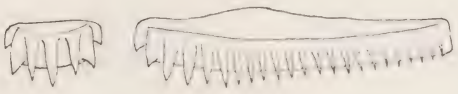

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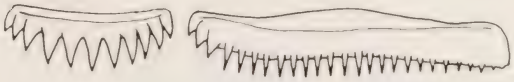

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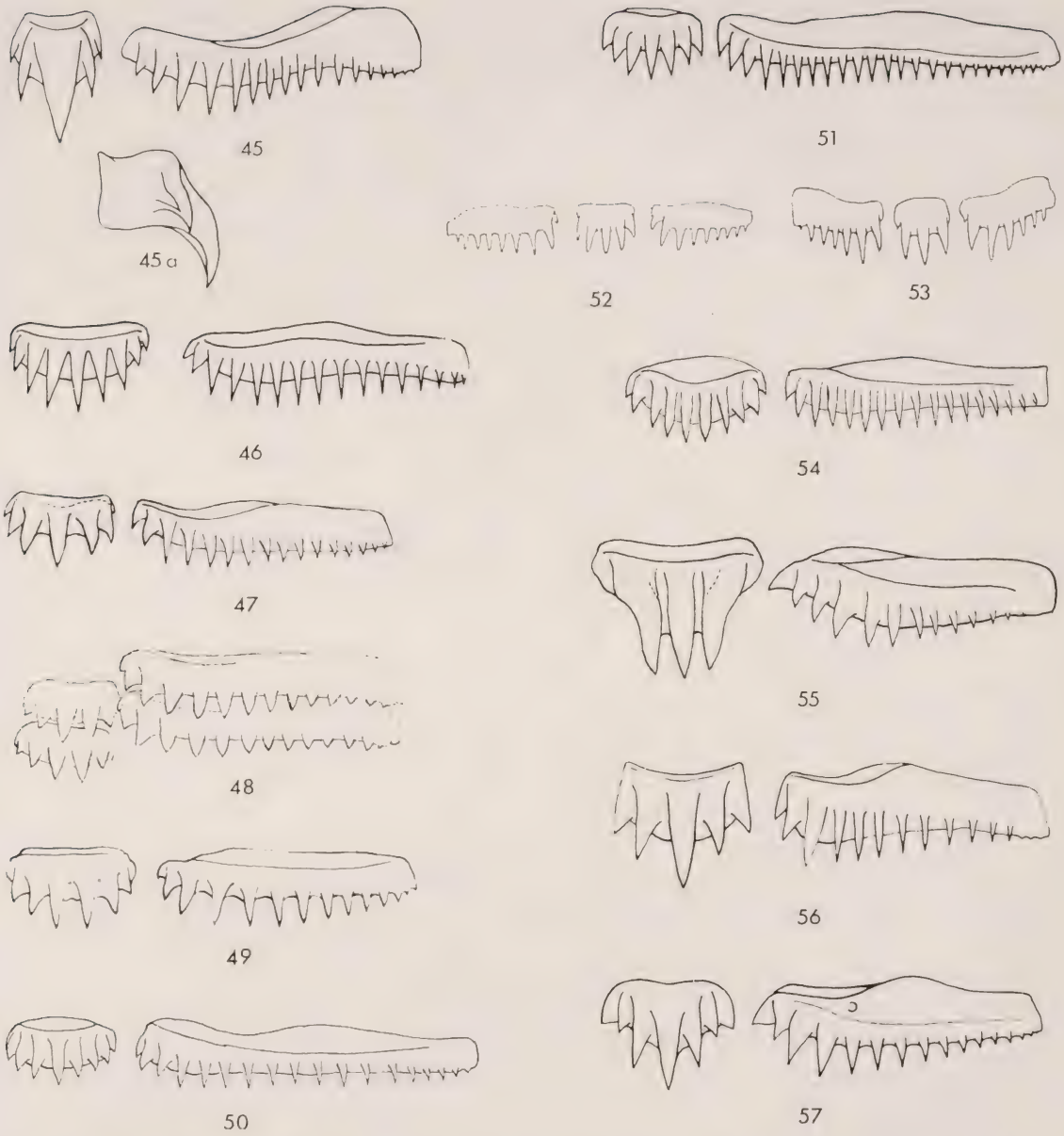
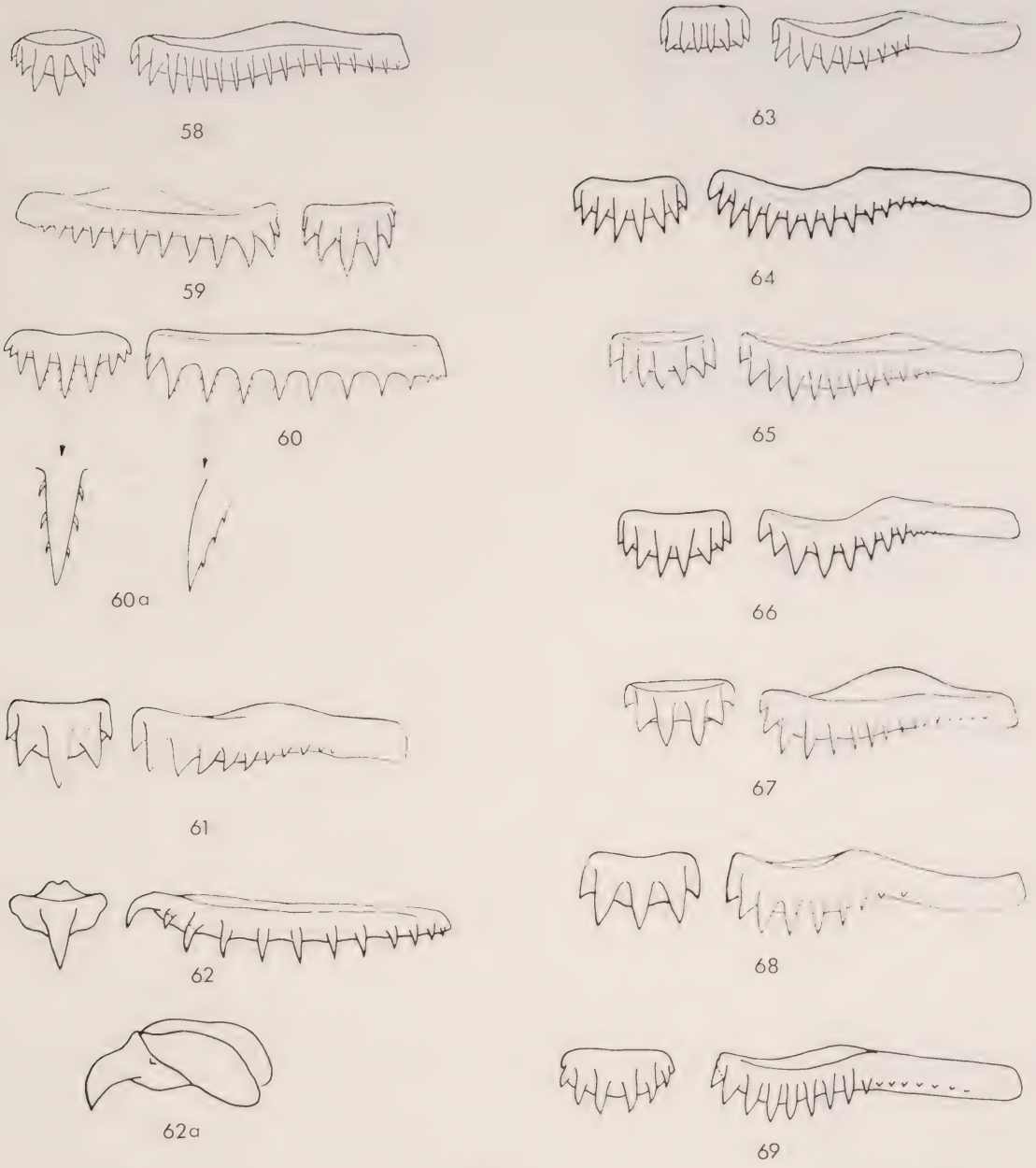
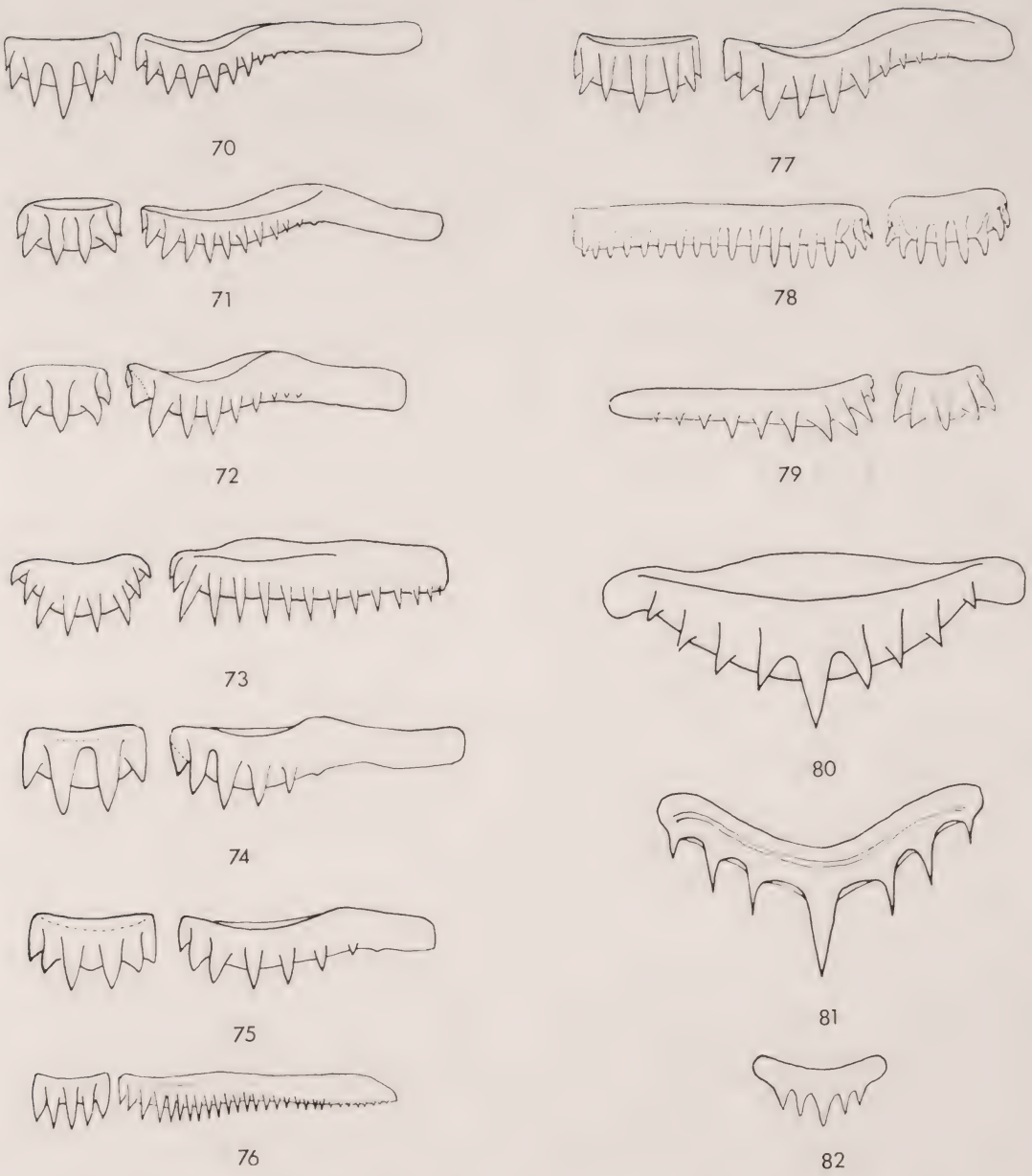
Radulae (ctd.). Fig. 32. *Mitra papalis* (Linnaeus), Sth. Pacific (after Cooke, 1920, fig. 2). Fig. 33. *M.belcheri* Hinds, Mazatlan, Mexico. Fig. 34. *M.barbadensis* (Gmelin), St. Croix, Virgin Islands. Fig. 35. *M.lens* (Wood), Venado, Bay of Panama. Fig. 36. *Mitra(Nebularia)nodulosa* (Gmelin), Galeta Point, E. coast of Panama.. Fig. 37. *M.(N.) nodulosa* (Gmelin), Varadero, Cuba. Fig. 37a. Rachidian of *M.(N.) nodulosa* (Gmelin), Bimini Islands. Fig. 38. *Mitra idae* Melvill, Point Conception, California. Fig. 39. *M.swainsonii* Broderip, off Guaymas, West Mexico (after J. Cate, 1967b, fig. 3 — as *M.zaca* Strong, Hanna & Hertlein). Fig. 40. *M.badia* Reeve, Flinders, Sth. Australia, intertidal. Fig. 41. *M.glabra* Swainson, Redhead, Bendalong, N.S.W., Australia. Fig. 42. *M.carbonaria* Swainson, Redhead, Bendalong, N.S.W., Australia. Fig. 43. *M.carbonaria* Swainson, High Island, Whangarei Heads, New Zealand, intertidal. Fig. 44. *M.variabilis* Reeve, Northwest Island, Queensland, Australia, intertidal.



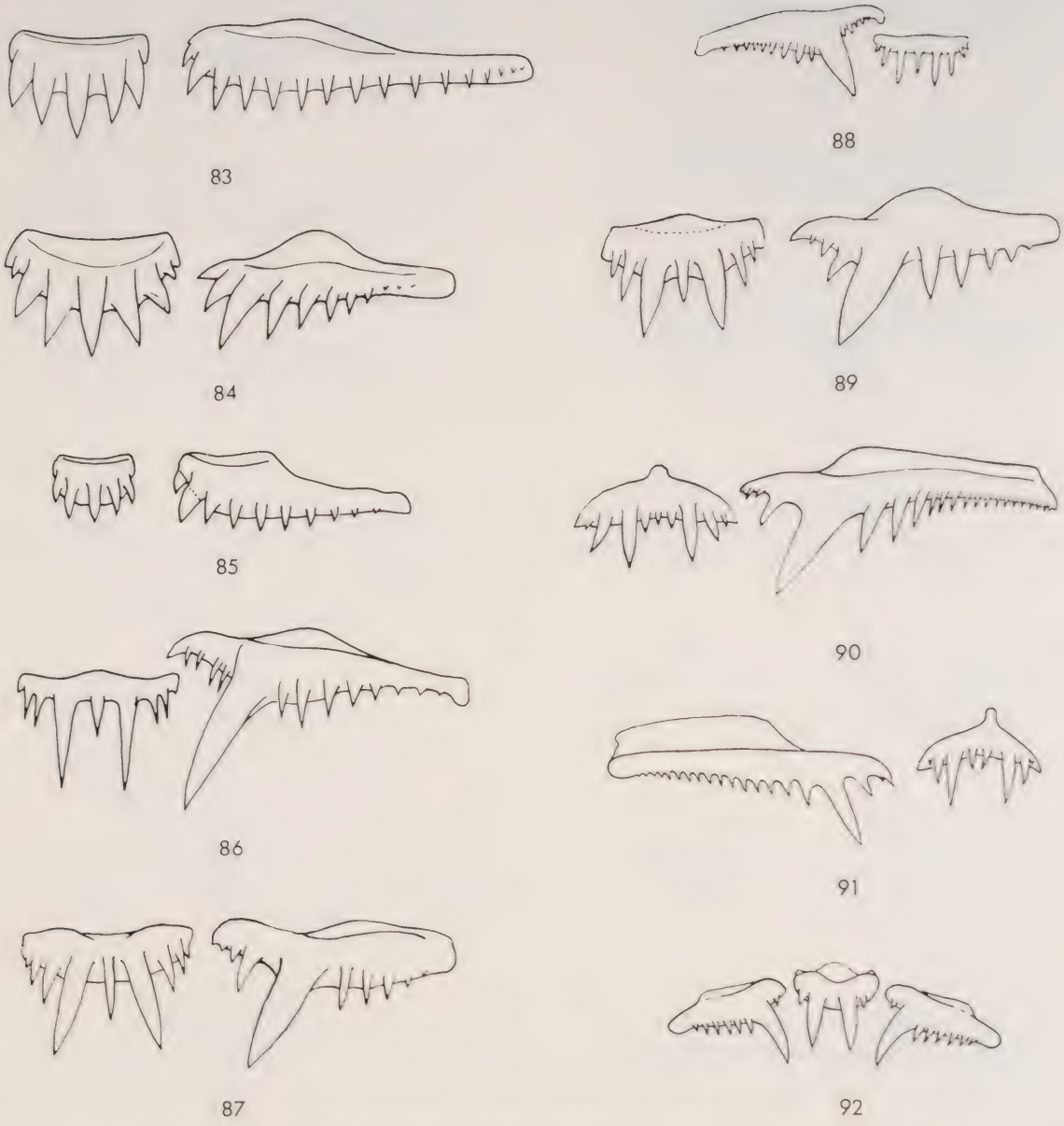
Radulae (ctd.) Fig. 45. *Mitra eremitarum* Röding, Fiji Islands, intertidal. Fig. 45a. Lateral view of rachidian of *M.eremitarum* Röding. Fig. 46. *M.fuscescens* Broderip, Kailua Bay, Oahu, Hawaiian Islands. Fig. 47. *M.ambigua* Swainson, Fiji Islands, intertidal. Fig. 48. *M.triplicata* Martens, (2 rows), Nth. off Brawa, East Africa, blue clay and mud, in 1362 metres (744 fathoms) (after Thiele in Martens, 1904, pl. 9, fig. 63). Fig. 49. *M.nivea* Broderip, Marau Sounds, Guadalcanal, Brit. Solomon Islands. Fig. 50. *M.rosacea* Reeve, Marinduque I., Philippine Islands. Fig. 51. *M.rosacea* Reeve, Kiushio I., Japan. Fig. 52. *Mitra(Nebularia)tabanula* Lamarck, (full row), Bulacan Bay, Philippine Islands (after Peile, 1937, fig. 13). Fig. 53. *M.(N.)tabanula* Lamarck, (full row), Bulacan Bay, Philippine Islands (after Peile, 1937, fig. 14). Fig. 54. *M.(N.) chrysalis* Reeve, Fiji Islands, intertidal. Fig. 55. *M.(N.) cucumerina* Lamarck, Fiji Islands, intertidal. Fig. 56. *M.(N.) ferruginea* Lamarck, Fiji Islands, intertidal. Fig. 57. *M.(N.) fraga* Quoy & Gaimard, Fiji Islands, intertidal.



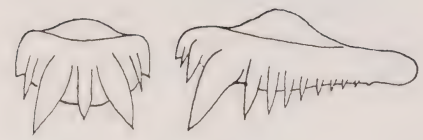
Radulae (ctd.). Fig. 58. *Mitra(Nebularia)floridula* Sowerby, Fiji Islands, intertidal. Fig. 59. *M.(N.)aurora* Dohrn, off Barber's Point, Oahu, Hawaiian Islands, in 2½ fathoms (5 metres) (after J. Cate, 1967b, fig. 5). Fig. 60. *M.(N.) tornata* Reeve, Fiji Islands, intertidal. Fig. 61. *M.(N.)straminea* A. Adams, off Palm Beach, Florida, in 70 fathoms (128 metres). Fig. 62. *M.(N.)turgida* Reeve, Fiji Islands, intertidal. Fig. 63. *M.(N.)aurantia* (Gmelin), Fiji Islands, intertidal. Fig. 64. *Mitra(Strigatella)retusa* Lamarck, Fiji Islands, intertidal. Fig. 65. *M.(S.)litterata* Lamarck, Fiji Islands, intertidal. Fig. 66. *M.(S.)paupercula* (Linnaeus), Fiji Islands, intertidal. Fig. 67. *M.(S.)fastigium* Reeve, Fiji Islands, intertidal. Fig. 68. *M.(S.)luctuosa* A. Adams, Taiohae Bay, Nukuhiva, Marquesas. Fig. 69. *M.(S.)scutulata* (Gmelin), Fiji Islands, intertidal.



Radulae (ctd.). Fig. 70. *Mitra*(*Strigatella*)*ticaonica* Reeve, Fiji Islands, intertidal. Fig. 71. *M.*(*S.*)*tristis* Broderip, Puertecitos, Baja California, Mexico, intertidal. Fig. 72. *M.*(*S.*)*tristis* Broderip, Port Utria, Colombia. Fig. 73. *M.*(*S.*) *auriculoides* Reeve, Fiji Islands, intertidal. Fig. 74. *M.*(*S.*)*pellisserpentis pellisserpentis* Reeve, Taiohae Bay, Nukuhiva, Marquesas. Fig. 75. *M.*(*S.*)*pellisserpentis astricta* Reeve, Black Point, Oahu, Hawaiian Islands. Fig. 76. *M.*(*S.*)*colombelliformis* Kiener, Rarotonga, Cook Islands, intertidal. Fig. 77.*M.*(*S.*)*decurtata* Reeve, Niue Island, intertidal. Fig. 78. *Mitra*(*Dibaphus*)*edentula* Swainson, Polynesia (after Cooke, 1920, fig. 4). Fig. 79. *Charitodoron pasithea* Tomlin, off Cape Natal, Sth. Africa, in 440 fathoms (805 metres) (after Barnard, 1959, fig. 11c — as *M.*(*Dibaphus*)*bathybius* Barnard). Fig. 80. *Pterygia nucea* (Gmelin) (full row), Fiji Islands, intertidal. Fig. 81. *Pterygia scabricula* (Linnaeus), (full row), Fiji Islands, intertidal. Fig. 82. *Pterygia crenulata* (Gmelin), (full row) (after Thiele, 1929, fig. 404).



Radulae (ctd.). Fig. 83. ?*Ziba flammea* (Quoy & Gaimard), Mauritius. Fig. 84. ?*Ziba bacillum* (Lamarck), Fiji Islands, intertidal. Fig. 85. ?*Ziba fulgetrum* (Reeve), Fiji Islands, intertidal. Fig. 86. *Subcancilla malleti* (Petit de la Saussaye), Fiji Islands, intertidal. Fig. 87. *S.annulata* (Reeve), Mataiea, Tahiti. Fig. 88. *S.flammigera* (Reeve), Durban, Sth. Africa (after Cooke, 1920, fig. 11). Fig. 89. *S.interlirata* (Reeve), off Yule I., Gulf of Papua, Papua, in 26 fathoms (48 metres). Fig. 90. *S.lineata* (Broderip), Panama Bay, Panama. Fig. 91. *S.attenuata* (Broderip), Bacochibampo, West Mexico, in 20 fathoms (37 metres) (after J. Cate, 1967b, fig. 8 — as *M.(C.)hindsii* Reeve). Fig. 92. *S. verrucosa* (Reeve), Mauban, Quezon, Philippine Islands (after J. Cate, 1967b, fig. 7).



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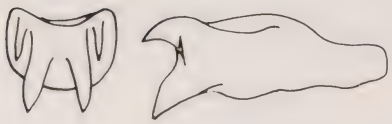

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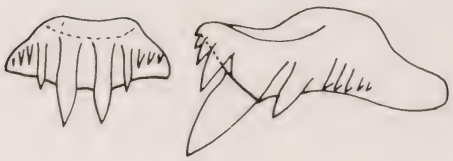

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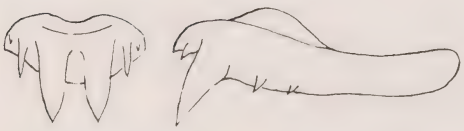

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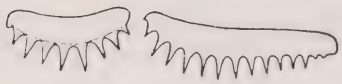

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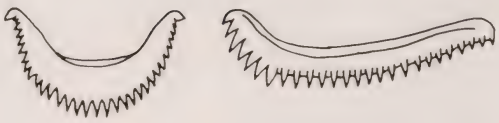

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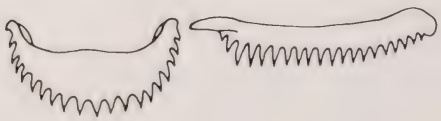

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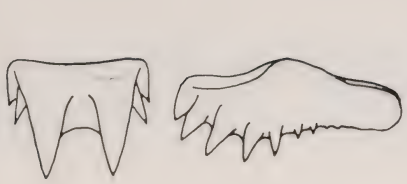
Radulae (ctd.). Fig. 93. *Imbricaria conularis* (Lamarck), Fiji Islands, intertidal. Fig. 94. *I.olivaeformis* (Swainson), Fiji Islands, intertidal. Fig. 95. *I.vanikorensis* (Quoy & Gaimard), Marau Sound, Guadalcanal, Brit. Solomon Islands. Fig. 96. *I.punctata* (Swainson), Fiji Islands, intertidal. Fig. 97. *I.conovula* (Quoy & Gaimard), Cocos-Keeling I., Indian Ocean (after Orr-Maes, 1967, fig. 4B — as *I.virgo* Broderip). Fig. 98. *I.bicolor* (Swainson), Le Goulet, Mauritius. Fig. 99. *Cancilla* (*Domiporta*) *filaris* (Linnaeus), Fiji Islands, intertidal. Fig. 100. *C.*(*D.*) *aerumnosa* (Melvill), Sth. Africa (after Barnard, 1959, fig. 11a). Fig. 101. *C.*(*D.*) *granatina* (Lamarck), Marau Sound, Guadalcanal, Brit. Solomon Islands. Fig. 102. *C.*(*D.*) *carnicolor* (Reeve), Fiji Islands, intertidal. Fig. 103. *C.*(*D.*)*praestantissima* (Röding), Marau Sound, Guadalcanal, Brit. Solomon Islands.



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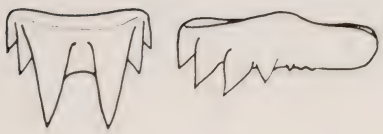

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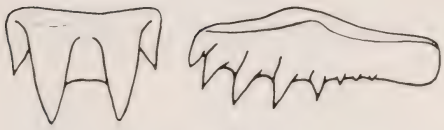

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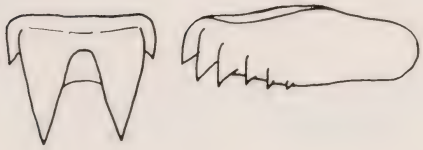

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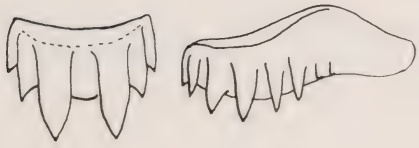

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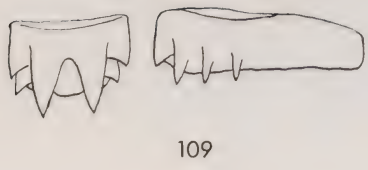

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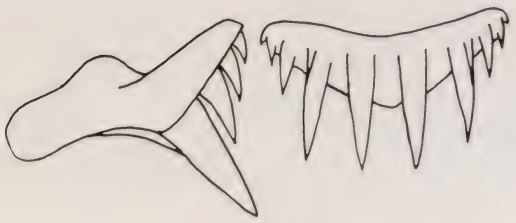

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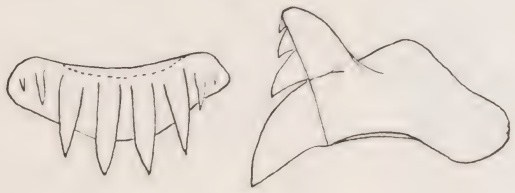

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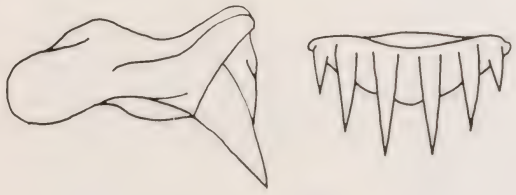
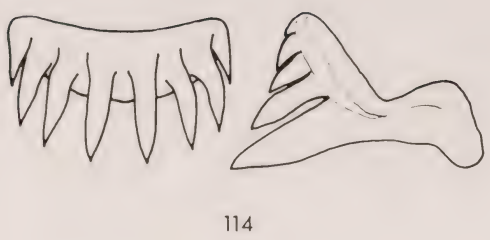


113

Radulae (ctd.). Fig. 104. *Neocancilla papilio* (Link), Fiji Islands, intertidal. Fig. 105. *N.papilio* (Link), Waianae, Oahu, Hawaiian Islands. Fig. 106. *N.clathrus* (Gmelin), Fiji Islands, intertidal. Fig. 107. *N.clathrus* (Gmelin), Kailua Bay, Oahu, Hawaiian Islands. Fig. 108. *N.takiisaoi* (Kuroda & Sakurai in Kuroda), 1 mile N.W. of Pitcairn Island. stone and coral rubble, 55-65 fathoms (101-119 metres). Fig. 109. *N.waikikiensis* (Pilsbry), off Makua, Oahu, Hawaiian Island, 7-8 fathoms (13-15 metres). Fig. 110. *Scabricola*(*Swainsonia*)*fissurata* (Lamarck), Rivière Noire, Mauritius, 17 fathoms (31 metres). Fig. 111. *S.*(*S.*)*casta* (Gmelin), Fiji Islands, intertidal. Fig. 112. *S.*(*S.*)*ocellata* (Swainson), Mackay, Queensland, Australia, intertidal. Fig. 113. *S.*(*S.*)*newcombii* (Pease), Kailua Bay, Oahu, Hawaiian Islands.



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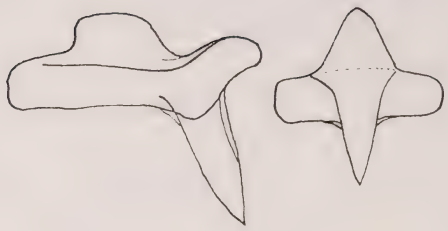

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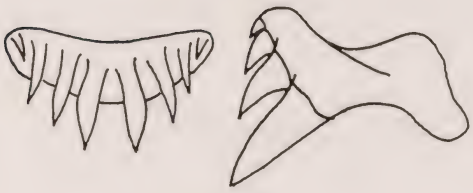

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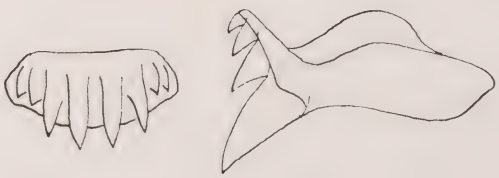

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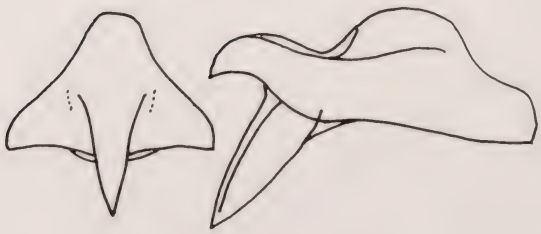

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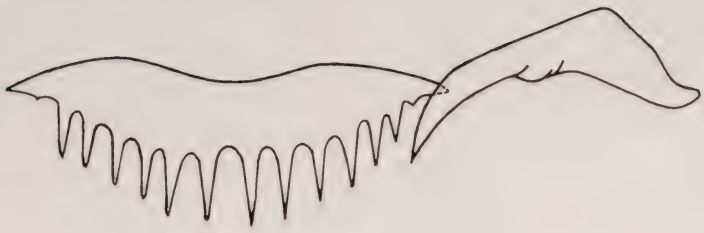
Radulae (ctd.). Fig. 114. *Scabricola*(*Swainsonia*)*fusca* (Swainson), Le Goulet, Mauritius. Fig. 115. *S.*(*S.*)*fusca* (Swainson), Fiji Islands, intertidal. Fig. 116. *Scabricola*(*Scabricola*)*variegata* (Gmelin), Fiji Islands, intertidal. Fig. 117. *S.*(*S.*)*desetangsii* (Kiener), off coast of Cabcaban, Bataan, Luzon, Philippine Islands. Fig. 118. *S.*(*S.*)*desetangsii* (Kiener) Mauritius. Fig. 119 & 119a. *S.*(*S.*)*padangensis* (Thiele), Fiji Islands, intertidal. Fig. 120. *S.*(*S.*)*coriacea* (Reeve), Indonesia, 22-57 metres (12-31 fathoms) (after Schepman, 1913, pl. 23, fig. 4).



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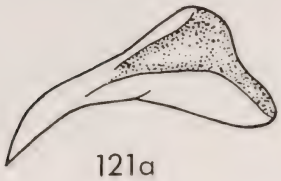

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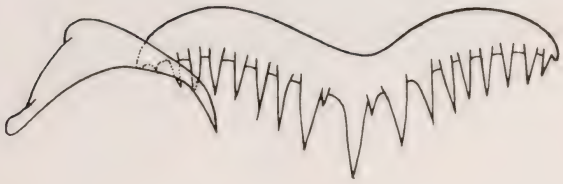

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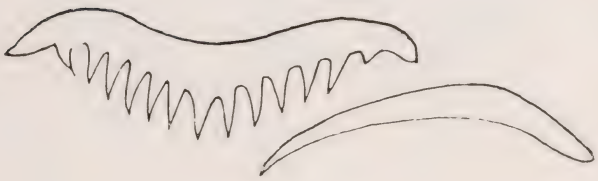

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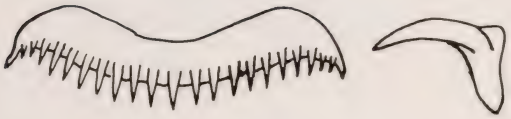

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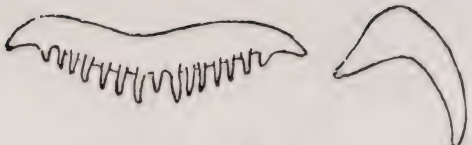

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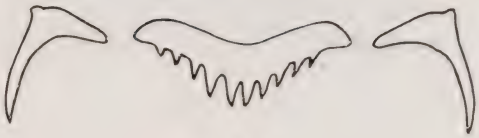

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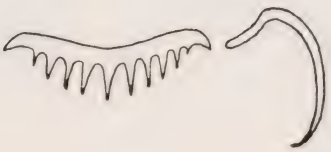

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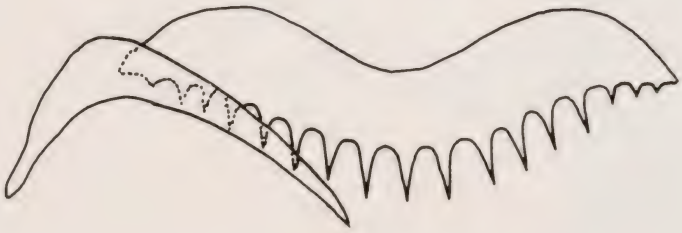

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Radulae (ctd.). Fig. 121. *Vexillum*(*Vexillum*)*plicarium* (Linnaeus), Fiji Islands, intertidal. Fig. 121a. Latero-dorsal view of rachidian. Fig. 122. *V.*(*V.*)*rugosum* (Gmelin), Hazelwood I., Whitsunday group, Queensland, Australia. Fig. 123. *V.*(*V.*)*coccineum* (Reeve) (after Azuma, 1965b, pl. 5, fig. 3 — as *V.ornatum coccineum* Reeve). Fig. 124. *V.*(*V.*) *gruneri* (Reeve), Fiji Islands, intertidal. Fig. 125. *V.*(*V.*)*subdivisum* (Gmelin), Singapore (after Peile, 1922b, fig. 2 — as *V.costellaris* Lamarck). Fig. 126. *V.*(*V.*)*taeniatum* (Lamarck), Akuilau I., Fiji Islands (after J. Cate, 1967b, fig. 9). Fig. 127. *V.*(*V.*)*isaoi* (Kuroda & Sakurai in Kuroda), Japan (after Azuma, 1965b, pl. 5, fig. 14). Fig. 128. *Vexillum* (*Costellaria*)*sanguisugum* (Linnaeus), Port Blair, Andaman Islands (after Peile, 1936, fig. 11). Fig. 129. *V.*(*C.*)*semifasciatum* (Lamarck), Fiji Islands, intertidal.

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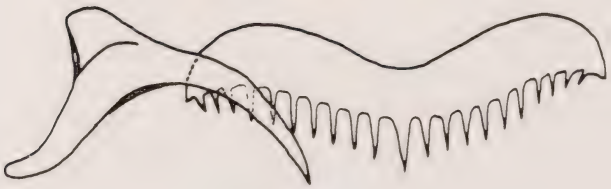

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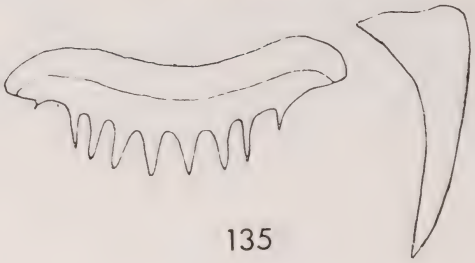

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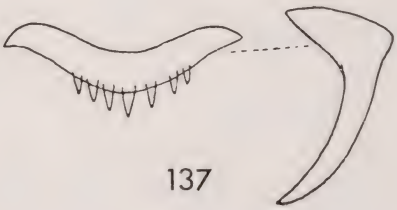

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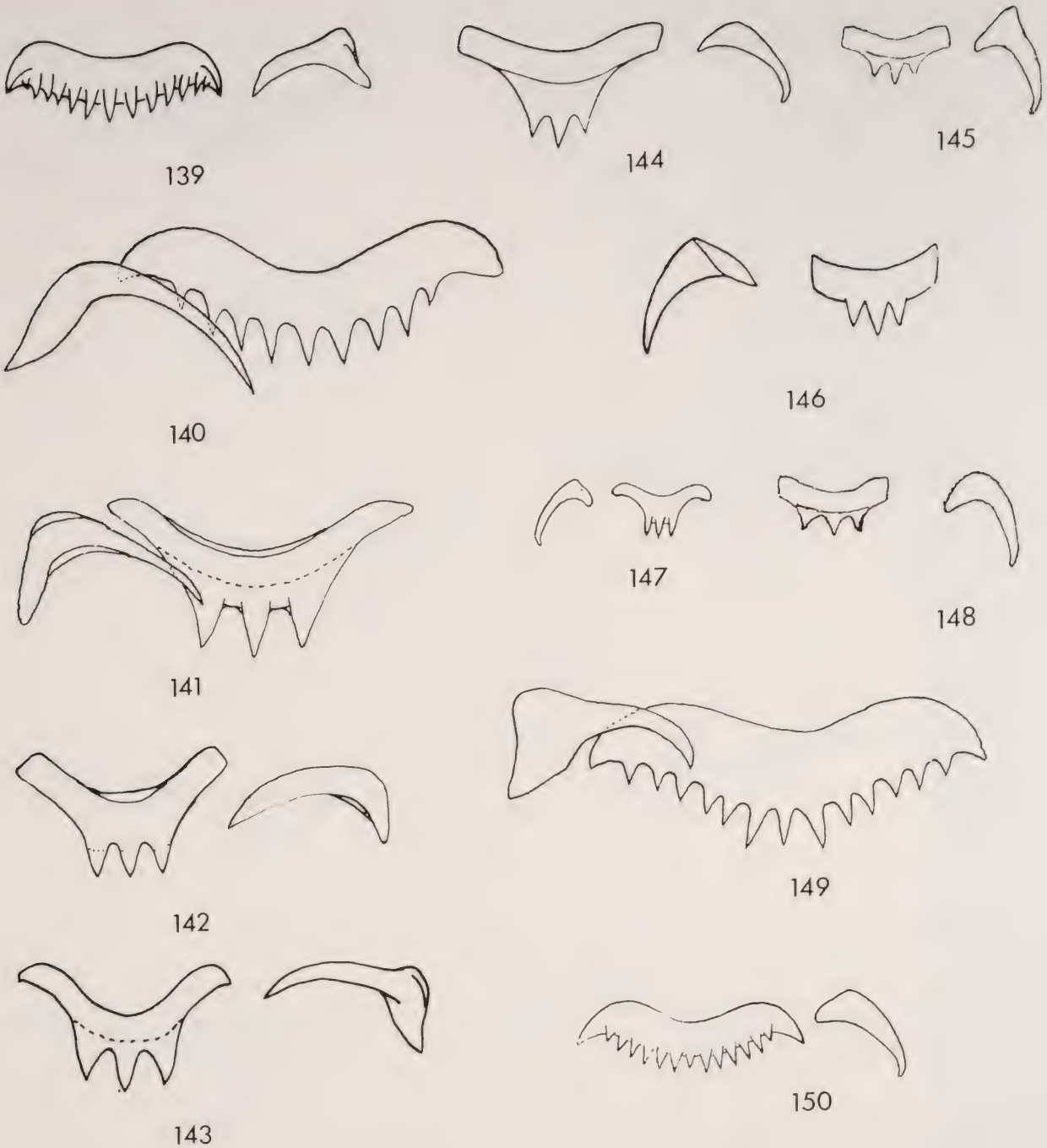
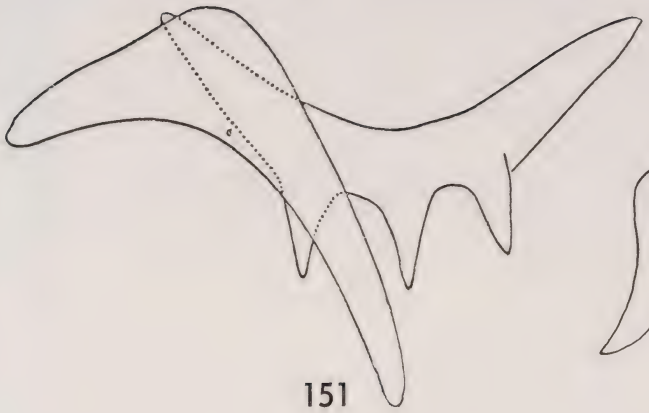
Radulae (ctd.). Fig. 130. *Vexillum(Costellaria)polygonum* (Gmelin), Kashiwajima, Tosa, Japan. Fig. 131. *V.(C.) exasperatum* (Gmelin), Fiji Islands, intertidal. Fig. 132. *V.(C.)cadaverosum* (Reeve), Fiji Islands, intertidal. Fig. 133. *V.(C.)cruentatum* (Gmelin), Saleyer, Indonesia (after Schepman, 1913, pl. 23, fig. 7). Fig. 134. *V.(C.)collinsoni* (A. Adams), Japan (after Habe, 1943, pl. 3, fig. 13). Fig. 135. *V.(C.)spicatum* (Reeve), Japan (after Azuma, 1965b, pl. 5, fig. 2). Fig. 136. *V.(C.)spicatum* (Reeve), Indonesia, 9-45 metres (5-25 fathoms) (after Schepman, 1913, pl. 23, fig. 8). Fig. 137. *V.(C.)fuscoapicatum* (E. A. Smith), Japan (after Habe, 1958, pl. 3, fig. 4 — as *Mitropifex bronni* Dunker). Fig. 138. *V.(C.)sculptile* (Reeve), Inhaca I., Delagoa Bay, Sth. Africa (after Barnard, 1959, fig. 11d).



Radulae (ctd.). Fig. 139. *Vexillum*(*Pusia*)*cancellarioides* (Anton), Fiji Islands, intertidal. Fig. 140. *V.*(*P.*)*luculentum* (Reeve), Fiji Islands, intertidal. Fig. 141. *V.*(*P.*)*patriarchalis* (Gmelin), Fiji Islands, intertidal. Fig. 142. *V.*(*P.*)*cavea* (Reeve), Taiohae Bay, Nukuhiva, Marquesas. Fig. 143. *V.*(*P.*)*consanguineum* (Reeve), Fiji Islands, intertidal. Fig. 144. *V.*(*P.*)*patula* (Reeve), South Africa (after Barnard, 1959, fig. 11f). Fig. 145. *V.*(*P.*)*patula* (Reeve), Durban, Sth. Africa (after Peile, 1922b, fig. 4 — as *Pusia merula* Sowerby). Fig. 146. *V.*(*P.*)*inermis* (Reeve), Japan (after Habe, 1943, pl. 3, fig. 10) — as *Pusia hizenensis* Pilsbry). Fig. 147. *V.*(*P.*)*australis* (Swainson), N. Tasmania (after Cooke, 1920, fig. 18). Fig. 148. *V.*(*P.*)*tricolor* (Gmelin), Malta (after Peile, 1922b, fig. 5). Fig. 149. *Austromitra rubiginosa* (Hutton), N. of Tutukaka Beach, Nth. Island, New Zealand, intertidal. Fig. 150. *A.capensis* (Reeve), Sth. Africa (after Barnard, 1959, fig. 11e).



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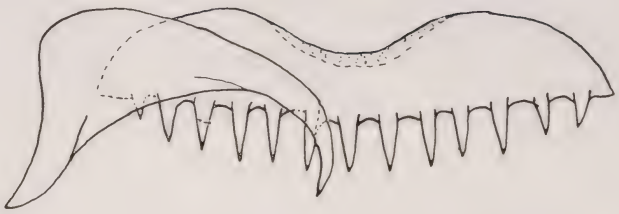

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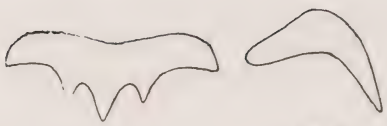

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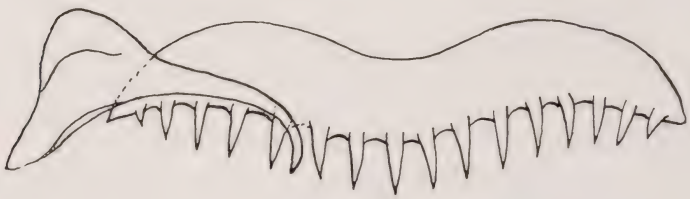

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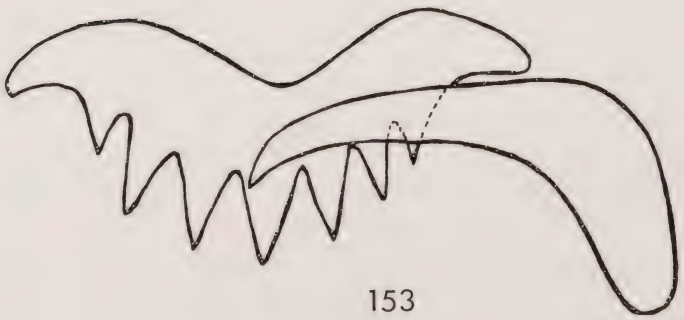

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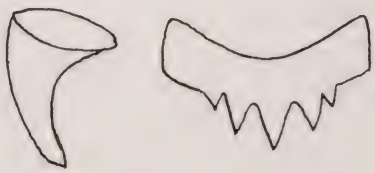

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Radulae (ctd.). Fig. 151. *Thala jeancateae* Sphon, off Tagus Cove, Albemarle I., Galápagos Islands, 50-60 fathoms (92-110 metres) (after Sphon, 1969, fig. 1). Fig. 152. *T.todilla* (Mighels) (after Thiele, 1929, fig. 394 — as *P.(Thala) simulans* Martens). Fig. 153. *T.gratiosa* (Reeve), San Luis Gonzaga Bay, Gulf of California, intertidal (after McLean, 1967, fig. 1 — as *Mitromica solitaria* C. B. Adams). Fig. 154. *Zierliana woldemarii* (Kiener), off coast of Cabcaban, Bataan, Luzon, Philippine Islands. Fig. 155. *Zierliana anthracina* (Reeve), off coast of Cabcaban, Bataan, Luzon, Philippine Islands. Fig. 156. *Thala exilis* (Reeve), Japan (after Habe, 1943, pl. 3, fig. 11 — as *Thala ogasawarana* Pilsbry).

CHROMOSOME STUDIES

The results of chromosome studies and their implications for molluscan classification deserve some mention despite the lack of data for the Mitridae. Menzel (1968) suggested that indications exist that chromosome numbers are constant within molluscan families, and hence may be of importance in systematic studies. Menzel's results unfortunately do not confirm this assumption, since chromosome numbers may not only be constant in different families and orders of marine molluscs, but also in marine and terrestrial molluscs. In the species *Mytilus edulis* Linnaeus, family Mytilidae, Order Filibranchia, the chromosome number is n=12; the same count has been recorded for *Dinocardium robustum* (Solander), in the family Cardiidae, Order Eulamellibranchia. In terrestrial snails, species of the same genus and family may have a different chromosome count (Laws, 1965). The chromosome number at meiosis of the terrestrial mollusc *Cochlicella acuta* (Müller) and *C.ventrosa* (Ferrusac) is n=23, which equals the number recorded for the marine pelecypod *Petricola pholadiformis* (Lamarck). Results seem to indicate that chromosome numbers may be constant within a family or within different families and orders of both marine and terrestrial molluscs, but may also differ within species of the same genus and family.

THE PROTOCONCH

The value of the gastropod protoconch as a diagnostic character in Mollusca has been discussed by several authors. Iredale (1911), Finlay (1931) and Laseron (1951), believed the features of the protoconch to be of superior value in classification, and contended that no two species are congeneric which have a different type of protoconch. Other writers disagreed with the preceding statement, rightly claiming that if this dictum were to be followed to its logical conclusion, chaos in taxonomy and incongruous results would be the outcome.

Dall (1889a, 1924), found nuclear characters to be of little absolute systematic value since a gastropod protoconch classification would produce preposterous combinations of dissimilar, and separation of similar, things. B. Smith (1907) was convinced that the protoconch as a means of generic discrimination had been greatly exaggerated.

Kesteven (1912) in a study of the gastropod protoconch, found that only those characters which reflect phylogenetic relationships may safely be used for taxonomic purposes, and that those most liable to variation are the most untrustworthy. He found the features of the gastropod protoconch to be plastic to environment, and unsuitable for either correlation or segregation. He pointed out that, as a taxonomic feature, the protoconch is practically worthless, and is liable and has sometimes proven to be, very misleading, due to the fact that its various forms have arisen from factors other than phylogenetic; only the radula has any real claim to be regarded as of phylogenetic significance.

Cossmann (1906) remarked that studies of the protoconch revealed results inadmissable for taxonomic classification, as long as they were based on non-objective interpretations.

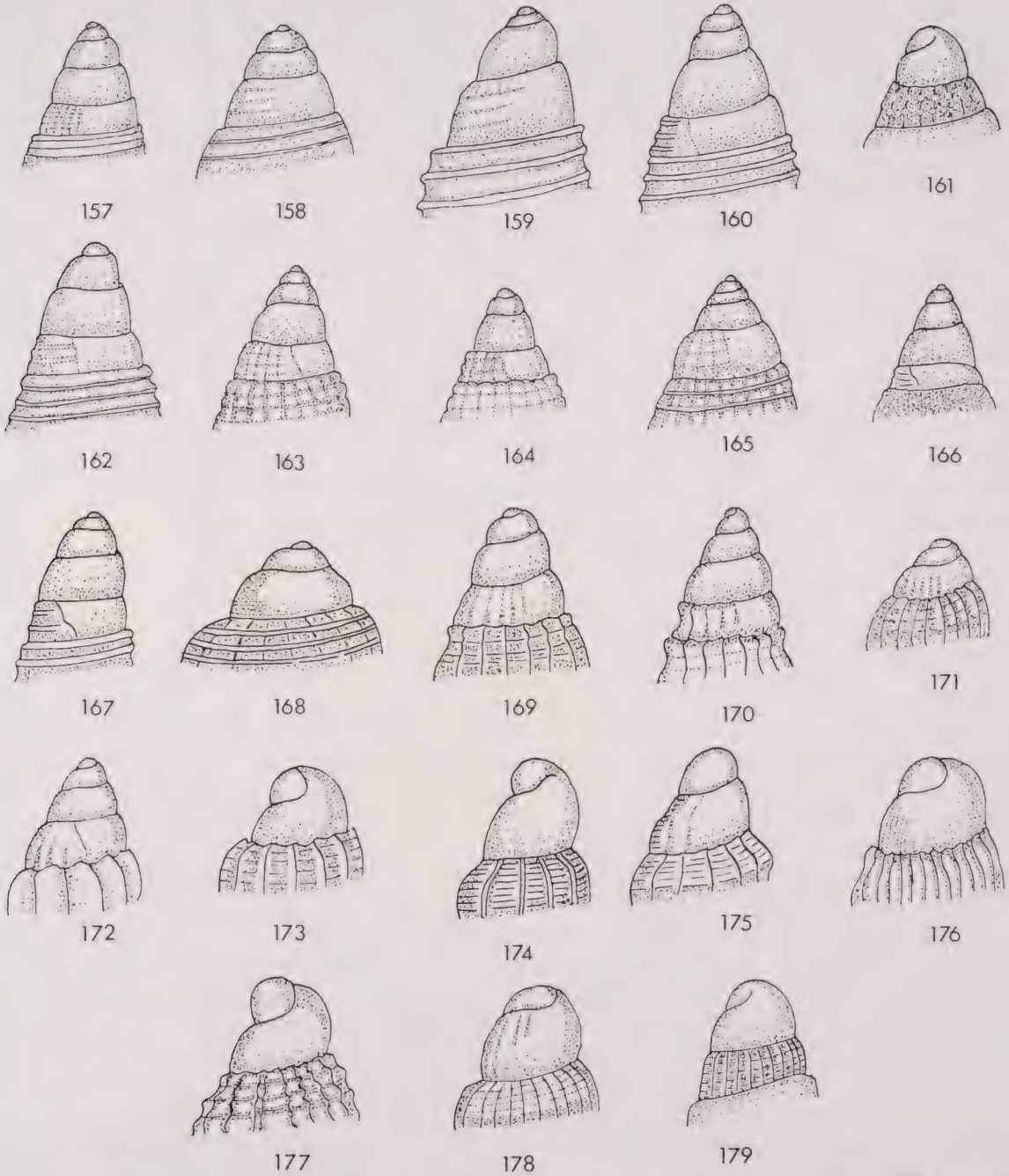
B. Smith (1945) summarized the results of his study by stating that "the characters of the protoconch are relatively uniform in some natural groups (*Fusinus, Busycon*), but may differ widely in some other natural groups (*Ficus, Conus, Athleta, Eucithara, Colus*, etc.).

Lemche (1948) remarked on the development of two different types of apices in a single species, and the resulting confusion if one species were placed in two genera.

Dell (1965) believed that the systematic value of the protoconch must take an important place in classification since protoconch features have been used in the past in molluscan classification by New Zealand and Australian workers. The author commented "that the structure of the protoconch in conjunction with the sum of other systematic characters assists greatly in determining generic relationships".

Personal observations of protoconchs of tropical gastropods inclusive of Mitridae have yielded results which disprove an absolute diagnostic importance for the protoconch, but at the same time do not render it utterly superfluous in classification. Specimens of a mitrid species collected in shallow water of the intertidal zone occasionally displayed a different type of protoconch than specimens of unquestionably the same species dredged from deeper water. When the term "different protoconch" is used here, the difference is not indicated by the number of nuclear whorls or size of coiling, but rather the direction of coiling and size of the primary nuclear whorl. It was found that some veligers of a species after metamorphosis had a different protoconch: a similar observation has been made in

Volutidae. It is to be assumed that any changes in protoconchal features take place during the embryonic stage, which is undoubtedly effected by environment. The developmental stage may be retarded or accelerated in species living in deeper water, with the resulting changes in the protoconch structure in comparison to shallow water populations. Juvenile shells may have twice as many nuclear whorls as adult specimens, and species with generally a straight protoconch will occasionally develop a tilted protoconch. On the whole, however, Mitridae, apart from a few vexilline and extinct genera, have a fairly uniform type of conoidal protoconch (Figs. 157 - 179) with smooth, glassy nuclear whorls.



Protoconchs of Mitridae. Fig. 157. *Mitra nivea* Broderip. Fig. 158. *M.badia* Reeve. Fig. 159. *Subcancilla attenuata* (Broderip). Fig. 160. *S.interlirata* (Reeve). Fig. 161. *Cancilla(Domiporta)strangei* Angas. Fig. 162. *C.(D.)filaris* (Linnaeus). Fig. 163. *C.(D.)carnicolor* (Reeve). Fig. 164. *Neocancilla clathrus* (Gmelin). Fig. 165. *Scabricola(Scabricola) desetangsii* (Kiener). Fig. 166. *Scabricola(Swainsonia)fissurata* (Lamarck). Fig. 167. *Imbricaria conularis* (Lamarck). Fig. 168. *Pterygia nucea* (Gmelin). Fig. 169. *Vexillum(Costellaria)cophinum* (Gould). Fig. 170. *V.(C.)nodospiculum* Cernohorsky. Fig. 171. *V.(C.)exasperatum* (Gmelin). Fig. 172. *V.(C.)etremoides* (Finlay). Fig. 173. *Vexillum(Pusia) australis* (Swainson). Figs. 174 & 175. *V.(P.)tricolor* (Gmelin). Fig. 176. *V.(P.)wandoense* (Holmes). Fig. 177. *Thala foveata* (Sowerby). Fig. 178. *Austromitra bucklandi* (Gabriel. Fig. 179. *A.rubiginosa* (Hutton).

The similarity of some mitrid protoconchs to the turrid genera *Austroclavus, Zemacies* and *Rugobela,* and those of the Volutomitridae to *Splendrillia* and *Cryptoconus,* could hardly be claimed to reflect phylogenetic relationship. It would be reasonable to assume that protoconch development and any resultant deviations occur in the embryonic rather than post-embryonic stage, and that environment plays an important part in the early developmental stages.

From all evidence on hand, it can be concluded that there can be no strict application of the "different protoconch" rule, nor can the protoconch be regarded as of absolute systematic value. In groups with a relatively uniform type of protoconch, the appearance of species with a prominently different protoconch should be regarded as an unnatural intrusion; deviation in protoconch structure within species due to environment or changes in the developmental stage, must be taken into account. Two species with similar shell-characters, anatomy, radula and living animal pattern, would not qualify for separation on the basis of differences in protoconch features. The value of the protoconch in classification is probably on a par in value with the operculum in operculate gastropods: useful in some groups (i.e. Turridae) but completely useless in others (i.e. Conidae).

GEOGRAPHICAL DISTRIBUTION AND PHYLOGENY

Three of the four subfamilies of Mitridae were already represented during Upper Cretaceous times. *Paleofusimitra* Sohl, from the Upper Cretaceous of the Gulf Coastal plain of Mississippi, is one of the earliest mitrine genera still retaining some fasciolarid features. *Mesorhytis* Meek, a once widely distributed Upper Cretaceous-Paleocene genus, is possibly the forerunner of the Vexillinae; species have been recorded from Upper Cretaceous deposits of Europe India and S.E. United States. *Imbricaria* (*Sohlia*) *conoidea* (Matheron), from the Turonian, Upper Cretaceous of France, is an ancentral stock of *Imbricaria.* The mitrid genera *Dentimitra, Fusimitra* and *Pseudocancilla,* made their appearance during the Paleocene and early Eocene, but did not survive the Oligocene. During Miocene times, the majority of surviving genera were already represented, and species of the Vexilline subgenus *Costellaria* were particularly numerous and widely distributed; they flourished in Europe, the Caribbean, India, Indonesia and the Pacific Islands, and were also represented in S.E. Australia and New Zealand. Species of *Cancilla, Ziba, Costellaria, Thala* and *Imbricaria* died out in Europe during Pliocene and Pleistocene times, but some of the species have survived in West Africa. Only the genera *Mitra* and *Pusia* survive in the Mediterranean region. The genus *Mitra* is still widely distributed, but species of *Zierliana, Vexillum, Scabricola, Pterygia* and *Dibaphus* are confined to the Indo-Pacific region. *Austromitra,* a genus of temperate water vexilline species, is restricted to Southern Australia, New Zealand and South Africa; in South America, the genus became extinct. Species of the genus *Thala* survive in the Indo-Pacific, Caribbean and the Eastern Pacific. *Charitodoron,* a group of plaitless, bucciniform deep water mitrine species, is confined to South Africa. *Dibaphimitra,* a subgenus ancestral to *Dibaphus,* contains a small group of inflated, pterygiaeform species with less numerous columellar folds and a wider aperture. *Dibaphimitra* was represented in the Miocene of Europe and S.E. Australia, and the Pliocene of Indonesia. One species from Florida and the Caribbean, i.e. *Mitra florida* Gould, and 2 probable Indo-Pacific species, i.e. *M.rossiae* Reeve and *M.albina* A. Adams, are the only surviving members of *Dibaphimitra.* The hypothetical phylogeny is shown in Fig. 180.

Woodring (1966), in a study of the Panama land bridge as a sea barrier to molluscan dispersal, remarked on the absence of a land bridge during all of the Tertiary; the barrier, however, was in full operation during the early Pleistocene. The similarity of Recent species of the Eastern Pacific and Caribbean provinces, suggest a common ancestry during the existence of the Tertiary Caribbean province. The four Eastern Pacific-Caribbean mitrid analogues are as follows:

Eastern Pacific	Caribbean
Mitra swainsonii swainsonii Broderip	*M.swainsonii antillensis* Dall
M.effusa Broderip	*M.barbadensis* (Gmelin)
M.nucleola Lamarck	*M.nodulosa* (Gmelin)
Thala gratiosa (Reeve)	*T.foveata* (Sowerby)

The large *Cancilla* s.str. were well represented during Mio-Pliocene times in Europe and the Tertiary Caribbean province. Only a few, moderately deep water species survive in the Sino-Japanese region, West Africa and Uruguay, but they became extinct in the Caribbean region.

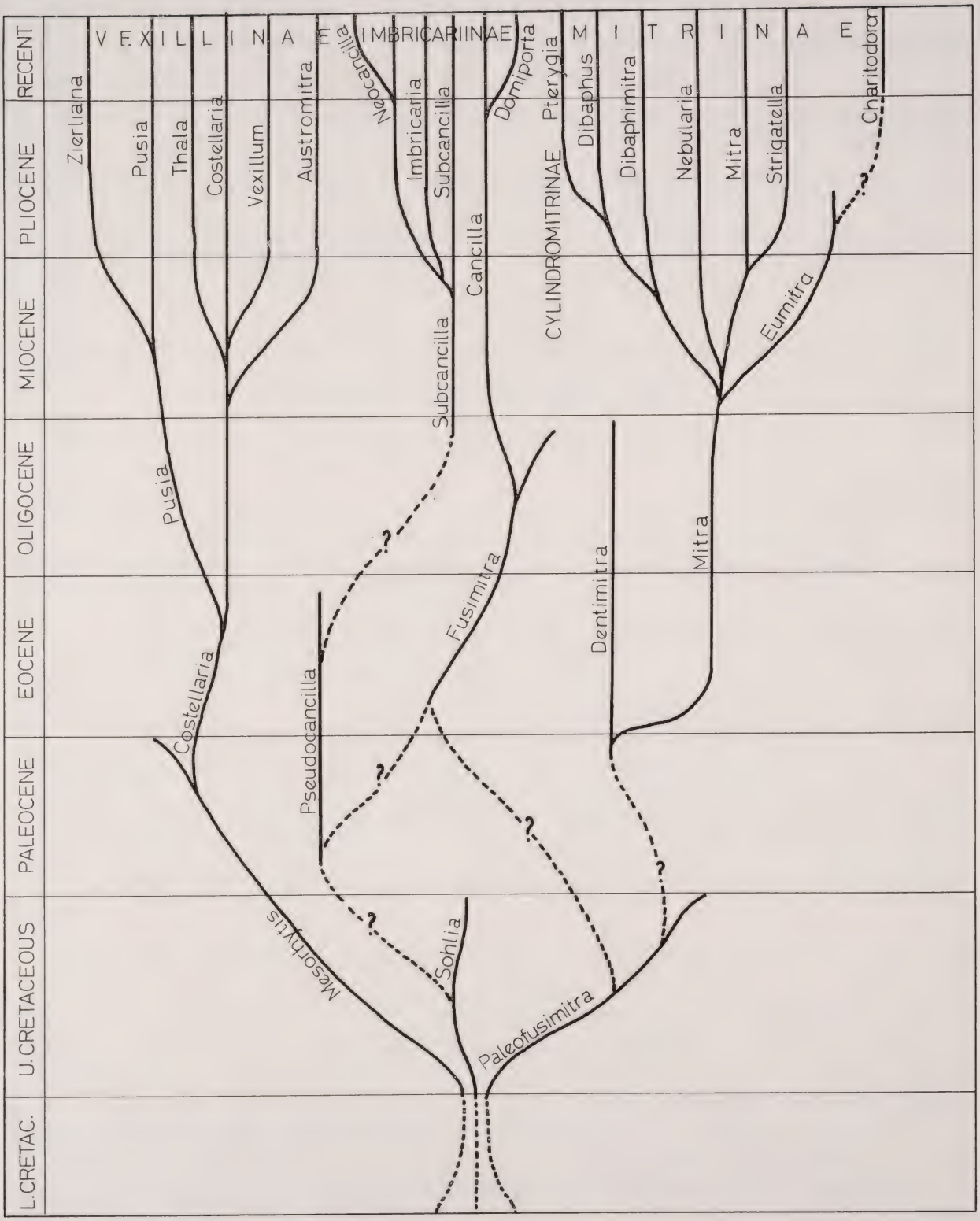


Fig. 180. Hypothetical phylogeny of the family Mitridae.

NEW TAXA PROPOSED

Sohlia n.subgen.—Type species *Mitra conoidea* Matheron, 1842. Upper Cretaceous of France.

Dibaphimitra n.subgen.—Type species *Mitra florida* Gould, 1856. Recent, Caribbean.

Domiporta n.subgen.—Type species *Voluta filaris* Linnaeus, 1771. Recent, Indo-Pacific.

Cancilla (Domiporta) gloriola nom.subst.pro *Mitra gracilis* Reeve, 1844 (non H. C. Lea, 1841). Recent, Philippines.

Vexillum (Costellaria) kalimnanense nom.subst.pro *Mitra terebraeformis* Tate, 1889. (non Conrad, 1848). Pliocene of Victoria, S.E. Australia.

Vexillum (Costellaria) lacertosum nom.subst.pro *Mitra paucicostata* Tate, 1889. (non Speyer, 1862; nec *Uromitra paucicostata* Bellardi, 1887). Miocene of Victoria, S.E. Australia.

LIST OF RECOGNISED GENERA AND SUBGENERA IN THE FAMILY MITRIDAE

(Asterisks indicate fossil genera and subgenera.)

Subfamily Mitrinae Swainson, 1831

Genus *Mitra* Lamarck, 1798.

Subgenus *Mitra* s.str. Lamarck, 1798. Eocene-Recent: Cosmopolitan.

Subgenus *Nebularia* Swainson, 1840. Eocene-Oligocene: Europe; India; Eastern Pacific; Miocene: Caribbean; India; Indonesia; New Zealand. Pliocene-Recent: Caribbean; Eastern Pacific; Indo-Pacific.

* Subgenus *Eumitra* Tate, 1889. Miocene-Pliocene: Australia; New Zealand.

Subgenus *Dibaphimitra* Cernohorsky, 1970 (herein). Miocene: Europe; S.E. Australia; Pliocene-Recent: Caribbean; Indo-Pacific.

Subgenus *Dibaphus* Philippi, 1847. Miocene: Caribbean. Recent: Indo-Pacific.

Subgenus *Strigatella* Swainson, 1840. Miocene: Caribbean; Indonesia. Recent: Eastern Pacific; Indo-Pacific.

* Genus *Paleofusimitra* Sohl, 1963. Upper Cretaceous: S.E. United States.

Genus *Charitodoron* Tomlin, 1932. Recent: South Africa.

* Genus *Dentimitra* Koenen, 1890. Paleocene-Oligocene: Europe; United States; Indonesia.

Subfamily Cylindromitrinae Cossmann, 1899

Genus *Pterygia* Röding, 1798. Pliocene-Recent: Indo-Pacific.

Subfamily Imbricariinae Troschel, 1867

Genus *Imbricaria* Schumacher, 1817.

Subgenus *Imbricaria* s.str. Schumacher, 1817. Miocene: Chile. Pleistocene: Europe. Recent: Indo-Pacific; West Africa.

* Subgenus *Sohlia* Cernohorsky, 1970 (herein). Upper Cretaceous: Europe.

Genus *Scabricola* Swainson, 1840.

Subgenus *Scabricola* s.str. Swainson, 1840. Miocene: Indonesia. Pliocene: Indonesia; New Hebrides. Recent: Indo-Pacific.

Subgenus *Swainsonia* H. & A. Adams, 1853. Recent: Indo-Pacific.

* Genus *Pseudocancilla* Staadt in Cossmann, 1913. Paleocene: Europe.

Genus *Subcancilla* Olsson & Harbison, 1953. Miocene: Caribbean; Indo-Pacific. Pliocene-Recent: Eastern Pacific; Indo-Pacific.

Genus *Ziba* H. & A. Adams, 1853. Miocene-Pliocene: Europe. Recent: West Africa; ? Indo-Pacific.

Genus *Cancilla* Swainson, 1840.

Subgenus *Cancilla* s.str. Swainson, 1840. Miocene: Europe; Caribbean; Indo-Pacific; S.E. Australia. Pliocene: Europe; Indo-Pacific. Recent: West Africa; E. coast Sth. America; Indo-Pacific.

* Subgenus *Fusimitra* Conrad, 1855. Eocene-Oligocene: United States.

Subgenus *Domiporta* Cernohorsky, 1970 (herein). Miocene-Pliocene: Indonesia. Recent: Indo-Pacific; S.E. Australia.

Genus *Neocancilla* Cernohorsky, 1966. Recent: Indo-Pacific; West Africa.

Subfamily Vexillinae Thiele, 1929

* Genus *Mesorhytis* Meek, 1876. Upper Cretaceous: Europe; India; N. & S.E. United States. Paleocene: N. United States.

Genus *Vexillum* Röding, 1798.

Subgenus *Vexillum* s.str. Röding, 1798. Pliocene - Recent: Indo-Pacific.

Subgenus *Costellaria* Swainson, 1840. Eocene-Miocene: Cosmopolitan. Pliocene-Recent: Europe; Caribbean; S.E. Australia; Indo-Pacific.

Subgenus *Pusia* Swainson, 1840. Eocene: Europe. Oligocene: Indonesia. Miocene: Europe; Caribbean; Indonesia. Pliocene: Europe; Indo-Pacific. Recent: Mediterranean; East Atlantic; Caribbean; Indo-Pacific.

Genus *Austromitra* Finlay, 1927. Miocene: Austral-Neozelanic region. Pliocene: Austral-Neozelanic region; Patagonia. Recent: Austral-Neozelanic region; South Africa.

Genus *Zierliana* Gray, 1847. Miocene: Indonesia. Recent: Indo-Pacific.

Genus *Thala* H. & A. Adams, 1853. Miocene: Europe. Recent: Caribbean; Eastern Pacific; Indo-Pacific; ? East Atlantic.

SYSTEMATICS

Class GASTROPODA

Subclass Prosobranchia

Order NEOGASTROPODA

Suborder Rachiglossa Gray, 1853

Superfamily VOLUTACEA Fleming, 1822

Family MITRIDAE Swainson, 1831

1831. Mitridae Swainson, Zool. Illust., ser. 2, 1: pls. 49, 50, 54 (nom. transl. H. & A. Adams, 1853—ex Mitranae Swainson, 1831).

1847. Mitrina Gray, Proc. Zool. Soc. Lond., 17: 141.

1853. Mitridae H. & A. Adams, Gen. Rec. Moll., 1: 167.

1857. Turritidae Gray, Guide syst. dist. Moll. Brit. Mus., p. 23 (for *Turris* Montfort, 1810 (non Röding, 1798) = *Vexillum* Röding, 1798; not available, art. 11c and 63 of ICZN).

1861. Turriculidae Carpenter, Ann. Rept. Smiths. Inst. Gen. App., p. 178 (for *Turricula* Fabricius & auctt. (non Schumacher, 1817) = *Vexillum* Röding, 1798; not available, art. 11c and 63 of ICZN).

1867. Mitracea Troschel, Geb. Schnecken, 2: 66.

1869. Strigatellacea Troschel, Geb. Schnecken, 2: 102.

1886. Mitridatae Jousseaume, Le Naturaliste, p. 221.

1889. Mitraeidae Locard, Exp. Sci. Trav. Talisman, 1: 150.

1890. Mitroeidea Locard, L'Échange Rev. Linn., 6 (61): 109.

1916. Nitridae Ayres, Cat. Conch. Exot. Coimbra, 1: 90.

1929. Vexillidae Thiele, Handb. syst. Weicht., 1: 337.

1951. Mitrariidae Carcelles & Williamson, Rev. Inst. Nac. Cienc. Nat. Argent., 2 (5): 301.

Shell: Small to large, 5-170mm, fusiform to cylindrical, teleoconch of 5-13 convex or angulate whorls, protoconch of 1-3½, smooth, often glassy nuclear whorls; protoconch generally conical, non-mamillate, but tending to be somewhat papillose in *Austromitra*. Surface rarely smooth, spiral sculpture of grooves, striae, cords, nodes or pits, axial sculpture of folds, ribs, granulations or growth striae; sutures distinct or obsolete, coronate in some species. Labial lip thin or thick, occasionally calloused, simple, crenulate or dentate, aperture wide or narrow, labrum smooth or lirate; columella with 3-10 folds in all Recent genera with the exception of *Charitodoron* which is edentulous; two fossil genera have only 1-2 columellar folds. Columella generally calloused and with a callus pad on the parietal wall in Vexillinae. Siphonal canal long or short, straight or recurved, siphonal notch generally distinct. Operculum is absent.

Animal: Animal with a moderate or large foot, bluntly truncated anteriorly, pointedly rounded posteriorly; in sand-dwelling species, the foot extends beyond the apex of the shell. Mantle thin, papillae absent; siphon long or short, thick or slender, simple at distal end. Eyes simple, pupil unicoloured or ringed, eyes situated near extremity of the broad base of the tentacles. Proboscis long or short, tentacles pointed. The animal of the South African deep water genus *Charitodoron* Tomlin, has no visual organs, according to Barnard (1960).

Some species of Mitridae discharge, when disturbed, a dark purple protective mucus (i.e., dibromindigotin), which has considerable staining properties, but is not harmful to humans.

The living animal of Mitridae has a colour pattern which is peculiar to a species. Variability of animal pattern is very slight indeed, and far less subject to changes than the shell itself. It is an invaluable tool in the elucidation of relationships of morphologically similar species.

Attacks upon species of Mitridae are fairly frequent, and sand-dwelling species fall prey to molluscan predators more frequently than rock-dwelling species. Naticidae and Muricidae are the main predators, and they drill perfectly round holes up to 3mm in diameter on the periphery of the penultimate and antepenultimate whorls. Bursidae and Cymatiidae will also attack species of Mitridae.

ANATOMY: Animals are dioecious, the penis is variable but generally curved and pointed, and situated behind the right tentacle; in life, the penis lies entirely under the mantle, facing towards the apex of the shell. Proboscis is either long or short, containing an odontophore which is secured to the wall by a pair of nerve tissues. Salivary glands are paired or coalescing, parts of the hypobranchial gland are modified for the secretion of dibromingotin; ducts are short. A venom gland is present in species of 3 subfamilies; its presence has not been confirmed in the Cylindromitrinae. The venom gland is long and slender, pointed, smooth and extendable through the proboscis. In *Neocancilla clathrus* (Gmelin), the gland measured 19.0mm in an animal with a shell 33.0mm in length. During an experiment conducted by Mrs. V. Orr-Maes at the Academy of Natural Sciences in Philadelphia, a specimen of the Caribbean *Thala foveata* (Sowerby) was observed killing a mollusc with its extendable venom gland. Since the tip of the venom gland is free of barbs or other puncturing device, the actual mechanics of killing the prey are a matter for conjecture.

RADULA: The radula is of the rachiglossan type, consisting of various patterns in different genera; the formula is 1-1-1 for all subfamilies, with the exception of Cylindromitrinae which have a 0-1-0 formula. The loss of laterals may be considered a step towards specialization; the more ancient Mitrinae still retain broad multicuspid laterals. The buccal mass is smallest in the genera *Pterygia, Vexillum* and *Domiporta* (4-5% of shell length), and is considerably longer in all other genera (9-17% of shell length). The odontophore is variable in colour, but generally translucent white, yellow, amber or rusty-brown. The rachidians range from unicuspid to multicuspid, while laterals are undergoing a reduction from the broad, multicuspid pattern of *Mitra* s.str. to the less broad and few-cusped laterals of *Scabricola* and simple, "sickle-shaped" laterals of the Vexillinae. A similar diversity in radula pattern may be observed in the Volutidae, where characters vary from the multicuspid rachidian of *Voluta* s.str., tricuspid rachidian of *Aulica* and *Cymbiola,* to the unicuspid rachidian of *Amoria.*

SPAWN: Rock dwelling mitrids deposit egg capsules on the underside of rocks and coral boulders, while sand-dwelling species deposit their spawn in weed. Egg capsules are deposited in loose asymmetrical clusters on a hard substratum or in tightly packed egg-clusters on sea-weed. The egg capsules are generally claviform, with 15-100 capsules per cluster, and with 100-500 white, cream-coloured or translucent-yellow eggs in each capsule. According to Ostergaard (1950), Mitridae have a free-swimming veliger larva, reaching the free-swimming stage 2 weeks from the date of incubation; an operculum is present in the veliger stage, but disappears in the adult stage. The loss and absorption of the veliger operculum has also been observed in the taenioglossate Cypraeidae.

ECOLOGY: Mitridae are either found buried in clean, muddy or silty coral sand, or inhabit the underside of rocks and coral boulders or cracks and crevices of coral reefs. About 85% of the known Recent species live within the intertidal zone, while a small minority live beyond the littoral zone to a depth of 1,465 metres (800 fathoms). In deeper water, specimens of Mitridae are dredged on coral rubble, sand or mud substratum. Mitridae are primarily carnivorous, although radular evidence suggests a divergence of feeding habits. The radula of sand-dwelling mitrids would appear to be particularly suitable for a tearing and shredding mode of feeding; in rock and coral dwellers, the broad and multicuspid surface of the plates would permit a wide coverage of the solid substratum during the feeding process. The rock dwellers are probably detritus feeders, subsisting on microorganisms attached to the hard substrate. In the Vexillinae, the anterior, fully formed rows of rachidians show only slight wear, but the sickle-shaped laterals are often broken and even missing; in Mitrinae, all cusps of the first dozen or more rows of teeth are worn down to the base of the cusps.

Sand-dwelling species are attracted to carrion, and flourish in areas of intertidal lagoons where food remains, particularly those of fish, are regularly discarded; the population density drops appreciably on either side of the "food-dump".

Sand-dwelling species of Mitridae bury themselves 50 - 100mm beneath the sand surface, and become active at the turn of the tide and at night; the tracks left in the sand by the larger species are quite prominent, moderately straight or irregular.

LOCOMOTION: Locomotion is achieved by waves of contraction along the foot and directed anteriorly; the rapid, undulating rippling of the foot is also visible on the anterior dorsal section of the foot.

The speed of forward movement on a sand substratum is moderately rapid: a specimen 25mm in length can cover a distance of 32mm in 10 seconds.

Geographical distribution: Mitridae are cosmopolitan, living in warm and temperate waters of both hemispheres, in all major geographical provinces from Latitude 42°N to 42°S.

Stratigraphical range: Upper Cretaceous—Recent.

Subfamily Mitrinae Swainson, 1831

1831. Mitrinae Swainson, Zool. Illust., ser. 2, 1: pls. 49, 50, 54 (nom. corr. Swainson, 1840—ex Mitrianae, Mitranae, Mitriana).

1840. Mitrinae Swainson, Treat. Malac., p. 98 (nom. corr.).

1887. Orthomitrinae Bellardi, Mem. R. Accad. Sci. Torino, 38: 79 (not available—art. 11e and 63 of ICZN).

1899. Pseudomitrinae (pars) Cossmann, Ess. paléoc. comp., 3: 151 (not available—art. 11e and 63 of ICZN).

1951. Mitrariinae Carcelles & Williamson, Rev. Inst. Nac. Inv. Cienc. Argent., 2 (5): 301.

Shell small to large, 5 - 170mm, solid, smooth, or plicate, striate and noduled. Protoconch paucispiral and conical in Recent species, variable in fossil species. In contrast to Vexillinae, interior of aperture always smooth in Recent and fossil Mitrinae, with exception of some fossil *Nebularia* species with "pseudo-lirae" on the labrum. Columella calloused, parietal callus lacking, siphonal notch distinct, columella with 3 - 10 oblique, close-set folds, first anterior fold the largest and strongest; siphonal canal short or produced. Periostracum thick or thin; venom gland present.

The animal has a shorter siphon and smaller foot than Vexillinae, the buccal mass, however, is generally larger and the proboscis longer in Mitrinae. Apart from the type species and a few other large mitrids, Mitrinae are predominantly rock and coral dwellers.

The radula of the Mitrinae is the prototypic mitrid radula, with small quadrate, rectangular, trapezoidal or triangular, unicuspid or multicuspid rachidians and broad, comb-like multicuspid laterals: the laterals are two to four times as broad as the rachidians. The mitrine radula bears a great resemblance to the Fasciolariidae. The radula undergoes slight modification in some species of Mitrinae, in the form of less comb-like and more cleaver-shaped laterals, which generally lack denticles on the ultimate one-third or one-quarter of the plate. A typically mitrine radula is occasionally found in species with strigatelliform shells, and a strigatelliform radula will occur in mitriform species.

Geographical distribution: Cosmopolitan. Indo - Pacific; Mediterranean; Atlantic; Caribbean; Eastern Pacific; Austral-Neozelanic region.

Stratigraphical range: Upper Cretaceous—Recent.

The subfamily contains 2 Recent genera, 4 Recent subgenera, 2 fossil genera and 1 fossil subgenus, exclusive of nominate subgenera; species are numerous.

Genus Mitra Lamarck, 1798

Subgenus Mitra s.str. Lamarck, 1798

(Plate 1, figs. 1-14 and Plate 2, figs. 1-5)

Mitra Lamarck, 1798, Tabl. Encycl. Méth., pl. 369. Type species by tautonomy *Voluta mitra* Linnaeus, 1758. Recent, Indo-Pacific. (Opinion 885 of I.C.Z.N.).

= 1784. *Mitra* Martyn, Univ. Conch., 1: pl. 19. Type species *M. tessellata* Martyn, 1784 = *Voluta incompta* Lightfoot, 1786, by SD (Dall, 1905). (non binom. — rejected Opinion 456 of ICZN).

= 1798. *Mitra* Röding, Mus. Bolten., p. 135. Type species by SD (Montfort, 1810) *Voluta episcopalis* Linnaeus, 1758 = *V.mitra* Linnaeus, 1758.

= 1815. *Mitraria* Rafinesque, Anal. nat. tabl. univ., p. 145. Type species (art. 67 of ICZN) *Voluta episcopalis* Linnaeus, 1758 = *V.mitra* Linnaeus, 1758.

= 1823. *Mitrolithes* Krüger, Gesch. Urwelt, 1: 431 (not available—art. 20 of ICZN).

= 1864. *Mitraxia* Binney & Tryon, Compl. writ. Rafinesque, p. 19 (nom. null.).

= 1880. *Mitrea* Garrett, J. Conch., 3: 44 (nom. null.).

= 1882. *Cucurbita* "Megerle MS", Scudder, Bull. U.S. Nat. Mus., No. 19: 93 (publ. in synonymy of *Mitra*).

= 1895. *Eumitra* Melvill & Standen, J. Conch., 8: 99. Type species by SD (Coan, 1966) *Mitra*(*Eumitra*)*episcopalis* (Linnaeus) = *Voluta mitra* Linnaeus, 1758 (non *Eumitra* Tate, 1889).

= 1915. *Papalaria* Dall, Bull. U.S. Nat. Mus., No. 90: 60. Type species by SD (Coan, 1966) *Voluta episcopalis* Linnaeus, 1758 = *V.mitra* Linnaeus, 1758. (genus without species).

1840. *Tiarella* Swainson, Treat. Malac., pp. 130, 131. Type species by SD (Gray, 1847) *Voluta papalis* Linnaeus, 1758 (first reviser Herrmannsen, 1847). Recent.

= 1840. *Thiarella* Swainson, Treat. Malac., p. 319 (nom. null.).

1853. *Isara* H. & A. Adams, Gen. Rec. Moll., 1: 171. Type species by SD (Cossmann, 1899) *Mitra bulimoides* Reeve = *M.glabra* Swainson, 1821. Recent.

= 1859. *Isaba* Chenu, Man. Conchyl., 1: 193 (nom. null.).

= 1880. *Isora* Hoernes & Auinger, Abh. k. k. geol. Reichsanst., 12 (2): 73 (nom. null.).

1853. *Mutyca* H. & A. Adams, Gen. Rec. Moll., 1: 172. Type species by SD (Wenz, 1943) *Dibaphus*(*Mutyca*)*ancilloides* (Swainson) = *Mitra ancillides* Broderip, 1836. Recent.

= 1878. *Vutyca* Kobelt, Illust. Conchyl., 1: 66 (nom. null.).

1880. *Phaeomitra* Martens, Beitr. Meeresf. Maurit. Seych., p. 252. Type species by SD (Coan, 1966) *Mitra*(*Phaeomitra*) *fulva* Swainson, 1829 = *Mitra coffea* Schubert & Wagner, 1829. Recent.

1900. *Fuscomitra* Pallary, J. Conchyl., 48 (3): 263. Type species by SD (Cox, 1936) *Mitra fusca* "Swainson" (sensu Reeve & auctt. — non Swainson, 1824) = *Voluta nigra* Gmelin, 1791 (misindentified type species—art. 70b of ICZN). Recent.

1917. *Episcomitra* Monterosato, Boll. Soc. Zool. Ital., 4 (3): 26. Type species by M *Mitra zonata* Swainson = *Mitra fusiformis zonata* Marryat, 1817. Recent.

1918. *Atrimitra* Dall, Proc. Biol. Soc. Washington, 31: 138. Type species by OD *Mitra idae* Melvill, 1893. Recent.

1929. *Vicimitra* Iredale, Austral. Zool., 5 (4): 343. Type species by M *V.prosphora* Iredale, 1929 = *Mitra solida* Reeve, 1844. Recent.

1956. *Cryptomitra* "Dall MS", Bryan, Hawaiian Shell News, 4 (4): 39 (nom. nud.).

1966. *Volvariella* Coan, Veliger, 9 (2): 132. Type species by OD *Mitra lamarckii* Deshayes, 1832 (non *Volvariella* Fischer, 1883). Recent.

Shell small to large, 5 - 170mm, fusiform, elongate-ovate to inflated, smooth or with spiral grooves, pits and granules, rarely with axial ribs; protoconch conical, paucispiral. Whorls convex or angulate, aperture shorter or longer than spire, labial lip thin or thick, simple or crenulate and dentate; labrum always smooth. Columella with 3 - 7 prominent, close-set, oblique and generally parallel folds; anterior canal not produced, siphonal notch prominent. Periostracum thin or thick.

Radula with unicuspid or multicuspid small rachidians and broad multicuspid laterals which are about two to four times the width of rachidians. The animal of the type species, i.e., *Mitra mitra* (Linnaeus), with a greyish-white foot mottled with dark brown, dorsum creamy-white and streaked with dark brown at edges. Siphon light grey, transversely finely lined with white, tentacles light grey, proboscis very long and bulbous at distal end.

Species of *Mitra* are predominantly rock and coral dwellers, but some species, including the type species, inhabit muddy and coralline sand. *Mitra* species live in shallow and deeper water, and have been dredged at a depth of 1,280 metres (700 fathoms); species living at these depths will tolerate a temperature as low as 11°C (45°F).

The holotype of *Mitra bulimoides* Reeve (BMNH No. 1966656: length 33.2mm, width 10.9mm), is a small, worn and faded specimen of *M.declivis* Reeve, which is a spirally corded form of *M.glabra* Swainson.

Atrimitra has been proposed by Dall (1918) for a group of Eastern Pacific "dark miters". It is rather unusual to base a new genus-group on shell colour or the colour of the periostracum, particularly when colour is such a variable factor in Mitridae. The periostracum of Eastern Pacific *Mitra* is almost black, but devoid of periostracum, the shells are creamy-white; specimens with their periostracum intact would therefore be placed in one genus group, while fossil and beach-worn shells would be assigned to another group. The Eastern Atlantic *Mitra nigra* (Gmelin) [= *fusca* auctt.] also has a black periostracum, and would qualify for assignment to the same group; since it is the type species of *Fuscomitra* Pallary, 1900, the latter genus group would have chronological priority over *Atrimitra* Dall.

Ponder (1968) suggested a retention of *Eumitra* Tate, previously known as *Vicimitra* Iredale, for a group of South Australian species which are "medium-sized, usually dark brown in colour, with a simple outer lip and a dull surface". The genus *Eumitra*, based on a S.E. Australian Miocene fossil, is used in this account as a subgenus, but in a different sense than is suggested by Ponder. If size or colour had any bearing in a generic diagnosis, then 20mm-long juveniles of *Mitra mitra* would be subgenerically separable from 150mm-long adults; albino specimens of the typically brown *M.badia* Reeve, would also deserve subgeneric recognition. *Vicimitra prosphora* Iredale, 1929 (= *Mitra solida* Reeve, 1844) has an orange-brown shell with white maculations, spiral threads and axial striae, and a labial lip which is minutely dentate in fresh, live collected specimens. Dark brown miters are by no means confined to S.E. Australia, and Indo-Pacific species such as *M.chinensis* Griffith & Pidgeon, 1934, *M.pele* Cernohorsky, 1970, *M.coffea* Schubert & Wagner, 1829, are only some of the species closely resembling the group under discussion.

The holotype of *Mitra ancillides* Broderip, 1836, the type species of *Mutyca* H. & A. Adams, remains unique, and a possibility exists that *M.ancillides* could prove to be a small specimen of the rather rare *M.nivea* Broderip, 1836. Both species are similar in form in the unusually numerous spiral threads and arrangement of columellar folds; the siphonal canal is more twisted in *M.ancillides* than is the case in *M.nivea*.

The designation of *Mitra fusca* "Swainson" as the type species of *Fuscomitra* Pallary by Cox (1936), is based on a misidentification of the species by Reeve (1844) and subsequent authors. The "*Mitra fusca*" of Reeve is the *Voluta nigra* of Gmelin, 1791, an Eastern-Atlantic - West African species (see Cernohorsky, 1970a). *Mitra fusca* Swainson, 1824, described originally from the Indian Ocean and subsequently well figured by Swainson (1831) and Kiener (1838), is an earlier name for the Indo-Pacific species *Scabricola*(*Swainsonia*)*zephyrina* (Sowerby, 1874). Similarly to *Atrimitra*, this genus group was based on the dark appearance of the shell.

The authorship of *Mitra* has been finally clarified by the International Commission on Zoological Nomenclature. In Opinion 885 (1969), the Commission ruled that the authorship of *Mitra* be credited to Lamarck, 1798, who established the genus in a plate heading in Latin in connection with illustrations of unnamed *Mitra* species. The type species of *Mitra* is *Voluta mitra* Linnaeus, 1758, by tautonomy, a name which has been placed on the Official List of Specific Names in Zoology, in preference to *Voluta episcopalis* Linnaeus, 1758, which has been rejected.

In Europe, the moderately large *Mitra* species made their appearance during the Early Eocene (*M.elongata* Lamarck), and continued to flourish till Early Pliocene (*M.fusiformis* Brocchi and allied species). *Mitra fusiformis zonata* Marryat, is the only large *Mitra* surviving in the Mediterranean region. By the Mid-Eocene, the Tethyan *Mitra* stock reached New Zealand (*M.hectori* Hutton), and the Caribbean region (*M.scotlandica* Trechmann). The Caribbean *M.scotlandica* and the Miocene species *M.titan* Gabb, are both ancestral to the Recent *Mitra swainsonii swainsonii* Broderip, from the Eastern Pacific and *M.swainsonii antillensis* from the Caribbean region. It may be remarked at this point that *Mitra zaca* Strong, Hanna & Hertlein, 1933, is only a large specimen of *M.swainsonii* s.str., and *Strigatella*(*Atrimitra*)*mexicana* Dall, 1919, is a small specimen of the same species (type of *M. swainsonii*: length 85.3mm; type of *M.zaca*; length 130.0mm; type of *M.mexicana*: length 71.8mm).

GEOGRAPHICAL DISTRIBUTION: Cosmopolitan. Indo-Pacific; Mediterranean; Atlantic; Caribbean; Eastern Pacific; Austral-Neozelanic region.

STRATIGRAPHICAL RANGE: Eocene - Recent.

CHARACTERISTIC SPECIES:

EOCENE — Europe: *elongata* Lamarck, 1803; *turriculata* Schafhäutl, 1863 (& Egypt). Caribbean: *scotlandica* Trechmann, 1925. California: *simplicissima* Cooper, 1894. Indonesia: *semicincta* Martin, 1931. New Zealand: *hectori* Hutton, 1905.

OLIGOCENE — Europe: *mettei* Giebel, 1864.

MIOCENE — Europe: *fusiformis* Brocchi, 1814; *pilsbryi* Boettger, 1906. Caribbean: *titan* Gabb, 1873. Peru: *swainsonii dunbari* Olsson, 1932. Chile: *martini* Philippi, 1887 (non Boettger, 1882). India: *birmanica* Vredenburg, 1923; *buddhaica* Vredenburg, 1923. Indonesia: *kelirensis* Martin, 1916. Japan: *hukusimana* Nomura & Zinbo, 1935; *kurakiensis* Hatai & Nisiyama, 1952.

PLIOCENE — Europe: *fusiformis* Brocchi, 1814; *melanopsiformis* Cox, 1936. California: *idae* Melvill, 1893. Indonesia: *ambigua* Swainson, 1829; *imperialis* Röding, 1798. Japan: *dainitiensis* Makiyama, 1927.

RECENT — Mediterranean: & East Atlantic: *cornicula* Linnaeus, 1758; *fusiformis zonata* Marryat, 1817; *nigra* Gmelin, 1791 (= *castanea* Röding 1798 = melaniana Lamarck, 1811 = *fusca* Reeve, 1844 & auctt.; = *adansonii* Philippi, 1849 = *aquitanica* Locard, 1890 = *escoffierae* Fontannes, 1880). Caribbean: *barbadensis* Gmelin, 1791 (= *striatula* Schröter, 1804 & Lamarck, 1811); *swainsonii antillensis* Dall, 1889. Eastern Pacific: *belcheri* Hinds, 1844; *caliginosa* Reeve, 1844 (= *induta* Sowerby, 1875 = *filius* Melvill, 1925); *catalinae* Dall, 1919 (= *diegensis* Dall, 1919); *effusa* Broderip, 1836; *fultoni* E. A. Smith, 1892; *idae* Melvill, 1893 (= *montereyi* Berry, 1920 = *coronadoensis* Baker & Spicer, 1930 = *semiusta* Berry, 1957); *lens* Wood, 1828 (= *foraminata* Broderip, 1836, = *dupontii* Kiener, 1838 = *lignaria* Reeve, 1844); *orientalis* Griffith & Pidgeon, 1834 (= *maura* Broderip, 1836 = *chilensis* Kiener, 1838 = *fortis* Melvill, 1925); *swainsonii swainsonii* Broderip, 1836 (= *mexicana* Dall, 1919 = *zaca* Strong, Hanna & Hertlein, 1933 = *woodringi* Olsson, 1964). S.E. Australia: *badia* Reeve, 1844 (= *castanea* A. Adams, 1853 = *rosettae* Angas, 1865); *carbonaria* Swainson, 1822 (= *nigra* Reeve, 1844 = *rhodia* Reeve, 1844 = *digna* A. Adams, 1855 = *abbreviata* Sowerby, 1874 = *maoria* Finlay, 1927 = *contermina* Iredale, 1936 = *sinusigera* Laseron, 1951); *cookii* Sowerby, 1874; *glabra* Swainson, 1821 (= *buccinata* Quoy & Gaimard, 1833 = *declivis* Reeve, 1844 = *bulimoides* Reeve, 1845 = *exposita* Iredale, 1936); *solida* Reeve, 1844 (= *prosphora* Iredale, 1929). New Zealand: *carbonaria* Swainson, 1822. Indo-Pacific: *ambigua* Swainson, 1829 (= *limosa* auctt. = *brevis* Dautzenberg, 1935); *ancillides* Broderip, 1836; *bovei* Kiener, 1838 (= *abacophora* Melvill, 1888); *cardinalis* Gmelin, 1791 (= *vermiculosa* auctt. = *monachialis* Röding, 1798 = *archiepiscopalis* Lamarck, 1811 = *pertusa* Swainson, 1822); *chalybeia* Reeve, 1844; *chinensis* Griffith & Pidgeon, 1834 (= *pigra* A. Adams, 1853 = *rutila* A. Adams, 1853 = *townsendi* Melvill, 1904); *coffea* Schubert & Wagner, 1829 (= *fulva* Swainson, 1829 = *attenuata* Reeve, 1844 = *thaanumiana* Pilsbry, 1921); *eremitarum* Röding, 1798 (= *adusta* Lamarck, 1811 = *flavofusca* Lamarck, 1811 = *ruffina* Dillwyn, 1817 = *brevior* Dautzenberg, 1935); *fasciolaris* Deshayes in Laborde & Linant, 1834 (= *arabica* Dohrn, 1861); *fulgurita* Reeve, 1844 (= *yaekoae* Habe & Kosuge, 1966); *fulvescens* Broderip, 1836 (= *telum* Sowerby, 1874 = *ostergaardi* Pilsbry, 1921 = *golishi* J. Cate, 1963 = *pararhodia* J. Cate, 1963); *guttata* Swainson, 1824 (= *floccata* Reeve, 1844 = *boswellae* J. Cate, 1964); *imperialis* Röding, 1798 (= *digitalis* Link, 1807 = *millepora* Lamarck, 1811 = *cribum* Dillwyn, 1817 = *koolhoveni* Oostingh, 1939); *incompta* Lightfoot, 1786 (= *terebralis* Lamarck, 1811 = *reevei* Philippi, 1850); *inquinata* Reeve, 1844 (= *hanleyana* Dunker, 1877 = *wrighti* Crosse, 1878); *lamarckii* Deshayes, 1832; *latruncularia* Reeve, 1844 (= *plebeia* Dohrn, 1860 = *albozonata* Turton, 1932 = *perexilis* Turton, 1932 = *tomliniana* Turton, 1932); *luctuosa* A. Adams, 1853 (= *nigricans* Pease, 1865 = *lamberti* Souverbie, 1875 = *astyridiformis* Melvill, 1888 = *albocoronata* Schepman, 1913 = *diamantina* J. Cate, 1963 = *alcida* J. Cate, 1963); *maesta* Reeve, 1845 (= *emiliae* Preston, 1908); *mitra* Linnaeus, 1758 (= *episcopalis* Linnaeus, 1758 = *carmelita* Röding, 1798); *nivea* Broderip, 1836 (= *norrisii* Reeve, 1844); *nubila* Gmelin, 1791 (= *versicolor* Lamarck, 1811 = *nivosa* Swainson, 1822 = *nebulosa* Reeve, 1844 = *propinqua* A. Adams, 1853 = *erronea* Dohrn, 1861 = *brettinghami* E. A. Smith, 1906); *nympha* Reeve, 1845; *papalis* Linnaeus, 1758; *pele* Cernohorsky, 1970; *petrosa* Sowerby, 1874; *picta* Reeve, 1844 (= ? *schroeteri* Link, 1807 = *tessellata* Kiener, 1838); *puncticulata* Lamarck, 1811 (= *diadema* Swainson, 1822 = *serpentina* Wood, 1828); *punctostriata* A. Adams, 1855 (= *marginata* Sowerby, 1874); *pyramis* Wood, 1828 (= *cancellata* Swainson, 1821 = *loricata* Reeve, 1844 = *japonica* A. Adams, 1864 - pars); *rosacea* Reeve, 1845 (= *hirasei* Pilsbry, 1904); *sanguinolenta* Lamarck, 1811 (= *prosanguinolenta* J. Cate, 1966); *sigillata* Azuma, 1965; *sophiae* Crosse, 1862; *stictica* Link, 1807 (= *pontificalis* Lamarck, 1811 = *thiara* Dillwyn, 1817 = *abbatis* Perry, 1811 = *coronata* Schumacher, 1817 = *confluens* Dautzenberg, 1935); *testacea* Broderip, 1836 (= *obliqua* Lesson 1842 = *antoni* Dohrn, 1860); *triplicata* Martens, 1904; *ustulata* Reeve, 1844 (= *ignobilis* Reeve, 1844 = *mosaica* Issel, 1869 = *kamehameha* Pilsbry, 1921); *variabilis* Reeve, 1844 (= *cylindrica* Reeve, 1844 = *polymorpha* Tomlin, 1920); *vaticinator* Melvill, 1918 (= *cretacea* Sowerby, 1874).

SUBGENUS Nebularia Swainson, 1840 (of *Mitra*)

(Plate 2, figs. 6 - 14)

Nebularia Swainson, 1840, Treat. Malac., pp. 130, 131, 319. Type species by SD (Herrmannsen, 1847) *Mitra contracta* Swainson, 1820. Recent, Indo-Pacific.

1853. *Chrysame* H. & A. Adams, Gen, Rec. Moll., 1: 171. Type species by SD (Cox, 1927) *Mitra coronata* Lamarck, 1811. Recent.

= 1938. *Chrysane* Suvatti, Moll. Siam., p. 37 (nom. null.)

= 1963. *Chysume* Shikama, Sel. shells world col., 1: pl. 74, fig. 8 (nom. null.)

Shell small to moderate in size, 8 - 60mm, biconic, roundly ovate to elongate ovate, rarely fusiformly elongate, solid. Protoconch conical, sutures simple or coronate, deep or shallow. Sculptured with spiral cords or spiral striae, interstices smooth or axially striate. Labial lip simple or crenulate, thickened, convex or contracted; aperture narrow, always smooth within. Columella with 3 - 6 prominent, oblique and parallel folds, anterior canal short or produced; siphonal notch generally distinct. Periostracum thin and opaque.

The radula and living animal pattern are the same as in *Mitra* s.str. *Nebularia* species are exclusively rock and coral dwellers; mainly shallow water inhabitants, some species are occasionally dredged

in deeper water on a coral rubble substratum. *Nebularia* is not a natural and well-defined group, as some characters tend to intergrade with *Mitra* s.str., but it is a convenient group term for the spirally corded, rock-dwelling species of *Mitra*.

Chrysame H. & A. Adams, does not differ sufficiently from *Nebularia* to merit recognition as a separate group. Individual specimens of *Mitra coronata*, mainly dead and worn examples, show a sculpture of punctate spirals, while other individuals are spirally corded. The sutures of *M.coronata* are obsoletely crenulate, but species with coronate and simple sutures also occur in *Mitra* s.str.

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific; Caribbean; Eastern Pacific; East Australia.

STRATIGRAPHICAL RANGE: Eocene - Recent.

CHARACTERISTIC SPECIES:

EOCENE — Eastern Pacific: *bolivarensis* Clark & Durham, 1946; *yasila* Olsson, 1930. India: *brachyspira* Cossmann & Pissarro, 1909.

MIOCENE — Europe: *exacuta* Bellardi, 1887 (= *casca* Bellardi, 1887); *substriatula* d'Orbigny, 1852. Caribbean: *acteoglypha* Gardner, 1937; *almagrensis* Toula, 1911 (= *coralliophila* Olsson, 1922); *mauryae* Anderson, 1929; *rudis* Gabb, 1873 (= *quemadica* Maury, 1917). India & Indonesia: *arntzenii* Martin, 1916; *bayeri* Beets, 1941; *kyaungonensis* Vredenburg, 1923; *sowerbyi* d'Orbigny, 1852 (= *fusiformis* J. de C. Sowerby, 1840 = *ardjunoi* Beets, 1941); *vandervlerki* Beets, 1941. New Zealand: *elatior* Finlay, 1924; *eusulcata* Finlay, 1924.

PLIOCENE — Caribbean: *compsa* M. Smith, 1938. Eastern Pacific: *almagrensis* Toula, 1911. India & Indonesia: *tornata* Reeve, 1845 (= *atjehensis* Oostingh, 1939 = *idjowensis* Oostingh, 1939 = *subidjowensis* Oostingh, 1939).

RECENT — Caribbean: *candida* Reeve, 1844; *nodulosa* Gmelin, 1791 (= *granulosa* Lamarck, 1811 = *granulata* Defrance in Blainville, 1824 = *monilifera* C. B. Adams, 1852 = *pallida* Nowell-Usticke, 1959); *semiferruginea* Reeve, 1845 (= *clara* Sowerby, 1874 = *fordi* Pilsbry & McGinty, 1949); *straminea* A. Adams, 1853 (= *multilirata* A. Adams, 1853 = *fluviimaris* Pilsbry & McGinty, 1949). Eastern Pacific: *crenata* Broderip, 1836 (= *lowei* Dall, 1903 = *loweana* Pilsbry, 1931 = *sphoni* Shasky & Campbell, 1964); *muricata* Broderip 1836 (= *rupicola* Reeve, 1844 = *gausapata* Reeve, 1845 = *marshalli* Bartsch, 1931); *nucleola* Lamarck, 1811 (= *inca* d'Orbigny, 1841). Indo-Pacific: *amaura* Hervier, 1898; *aurantia* Gmelin, 1791 (= *minuta* Röding, 1798 = *aurantiaca* Lamarck, 1811 = *limacina* Lamarck, 1811 = *peronii* Lamarck, 1811 = *crassa* Swainson, 1822 = *michelinii* Guérin, 1831 = *consolidata* Sowerby, 1874 = *carifa* Bartsch, 1915); *aurora* Dohrn, 1861; *avenacea* Reeve, 1945 (= *hanleyi* Sowerby, 1874); *chrysalis* Reeve, 1844 (= *leucozona* Küster, 1839 = *caledonica* Récluz, 1853 = *buryi* Melvill & Sykes, 1899); *chrysostoma* Broderip, 1836 (= *kieneri* Philippi, 1850 = *arnaloti* Bartsch, 1918); *coarctata* Reeve, 1844; *contracta* Swainson, 1820 (= *abbatis* Dillwyn, 1817 = *nebulosa* Broderip, 1836 = *infecta* Reeve, 1844 = *barclayi* Sowerby, 1874); *coronata* Lamarck, 1811 (= *tiarella* A. Adams, 1853 = *honoluluensis* Pilsbry, 1921 = *amplificata* Dautzenberg & Bouge, 1923 = *crassula* J. Cate, 1963); *crassicostata* Sowerby, 1874; *cucumerina* Lamarck, 1811 (= *ferrugata* Dillwyn, 1817 = *globosa* Mörch, 1852 = *pallida* Dautzenberg & Bouge, 1923); *doliolum* Küster, 1839 (= *rotundilirata* Reeve, 1844); *ferruginea* Lamarck, 1811 (= *vitulina* Dillwyn, 1817 = *martiniana* Menke, 1829 = *williamsi* Newcomb, 1870 = *lemma* Iredale, 1929); *floridula* Sowerby, 1874; *fraga* Quoy & Gaimard, 1833 (=*miniata* Anton, 1839 = *peregra* Reeve, 1844 = *spadicea* Sowerby, 1874 = *echyra* Melvill, 1925); *lienardi* Sowerby, 1874 (= *emaciata* Dautzenberg & Bouge, 1923); *lugubris* Swainson, 1821; *pediculus* Lamarck, 1811 (= *sulcata* Menke, 1829 = *palawanensis* Bartsch, 1918); *punctata* Swainson, 1829; *rubiginosa* Reeve, 1844; *ruepellii* Reeve, 1844 (= *planilirata* Reeve, 1844); *rubritincta* Reeve, 1844; *solanderi* Reeve, 1844; *suturata* Reeve, 1845 (= *sibogae* Schepman, 1913); *tabanula* Lamarck, 1811 (= *minor* Sowerby, 1874 = *trunculus* Sowerby, 1874 = *connectens* Dautzenberg & Bouge, 1923); *tornata* Reeve, 1845 (= *cingulata* A. Adams, 1853—pars; = *rubiginea* A. Adams, 1855 = *carinilirata* Souverbie, 1871); *turgida* Reeve, 1845 (= *ericea* Pease, 1860 = *indentata* Sowerby, 1874).

SUBGENUS **Eumitra** Tate, 1889 (of *Mitra*)

(Plate 3, figs. 1 - 5)

Eu-Mitra Tate, Trans. Roy. Soc. Sth. Australia, 11: 135. Type species by SD (Cotton, 1957) *Mitra alokiza* Tenison-Woods, 1880. Miocene of S.E. Australia.

= 1954. *Iumitra* Ludbrook, Trans. Roy. Soc. Sth. Australia, 77: 53 (nom. null.).

= 1966. *Eurmitra* Macpherson, Mem. Nat. Mus. Melbourne, 27: 255 (nom. null.).

1927. *Diplomitra* Finlay, Trans. N.Z. Inst., 57: 408, 477. Type species by OD *Cymbiola nitens* Marshall, 1918. Miocene of New Zealand.

Shell moderate in size, up to 60mm in length, fusiformly elongate or fusiformly ovate, whorls convex or subangulate, protoconch conical. Sculptured with smooth or punctate spiral striae, irregular axial growth lines and basal cords; spiral striae occasionally confined to the sutures and base. Labial lip thin or thick, simple, contracted anteriorly in adult specimens. Aperture shorter than the spire, smooth within; columella with 1 - 5 oblique folds. Anterior canal slightly produced, siphonal notch distinct.

Species of *Eumitra* Tate, resemble *Mitra* s.str., but differ in the peculiar development of the columellar folds, a character not observed in living *Mitra* species. Irrespective of the developmental stage, juveniles or adults may have up to 5 columellar folds or only 1 single prominent fold with a feeble indication of a second anterior fold. Harris (1897), remarked that a specimen of *M.alokiza* which he examined had only 2 columellar folds; several specimens of *M.alokiza* examined personally, had only 1 prominent fold with the indication of a second fold. *Eumitra* Tate will have to replace *Diplomitra* Finlay, a genus based on the characteristic feature of a reduction of columellar folds to 1 + 1.

Species of *Eumitra* have been recorded from Lower Miocene deposits at Table Cape, Tasmania, Mid-Miocene beds at Muddy Creek, Victoria, Late Miocene deposits at Tareena, N.S.W. and Lower Pliocene deposits at Dry Creek Sands, South Australia. In New Zealand, *Eumitra* is confined to the Lower Miocene deposit at Pakaurangi Point and Waiheke Island.

Some of the specific names bestowed upon Australian and New Zealand *Eumitra* species appear to have been based on specimens of different developmental stages. *Mitra dictua* Tenison-Woods, from the Lower Miocene of Table Cape, seems to be a good species; the early whorls are axially costate, the spiral threads are coarse and finely granulose and the columella has 2 - 3 folds. Differences between *M.alokiza, M.diductua* and *M.uniplica* are rather nebulous. In the immature stage, *M.alokiza* has flat-sided whorls, but in the adult shell, the last one or two whorls become subangulate, and the columella more calloused. Marshall (1918) described 3 *Eumitra* species from Lower Miocene deposits at Pakaurangi Point. The small 9mm long and badly preserved type of *E.calcar* appears to be a juvenile of *E.masefieldi* Marshall, while *E.nitens* is a larger but immature specimen of the same species.

GEOGRAPHICAL DISTRIBUTION: Australia and New Zealand.

STRATIGRAPHICAL RANGE: Lower Miocene — Lower Pliocene.

CHARACTERISTIC SPECIES:

MIOCENE — Australia: *alokiza* Tenison-Woods, 1880; *dictua* Tenison-Woods, 1880; *diductua* Tate, 1889 (= *fodinalis* Tate, 1899); *uniplica* Tate, 1889 (= *monoploca* Finlay, 1927). New Zealand: *masefieldi* Marshall, 1918 (= ? *calcar* Marshall, 1918 = *waitemataensis* Powell & Bartrum, 1929); *nitens* Marshall, 1918.

PLIOCENE — Australia: *diductua* Tate, 1889; *coxi* Ludbrook, 1958.

SUBGENUS **Dibaphimitra** nov. subgen. (of *Mitra*)

(Plate 3, figs. 6 - 8)

Type species (here designated) *Mitra florida* Gould, 1856. Recent, Florida & Caribbean.

Shell moderate in size, 25 - 80mm, pterygiaeform, ovate, last whorl inflated. Teleoconch of 4 - 6 convex whorls, protoconch of $1\frac{1}{2}$ - $3\frac{1}{2}$ glassy, smooth nuclear whorls. Sculptured with fine spiral threads and spiral cords on siphonal canal. Aperture longer than spire, wide or only slightly constricted, smooth within; labial lip simple, convex or slightly angulate. Columella with 4 - 7 oblique folds (6 - 7 in type species), first posterior fold more prominent than remaining folds; anterior part of columella calloused, siphonal notch distinct.

The animal has a milky white body with blotches and cloudings of rich brown irregularly scattered over the sides; the tentacles, head, proboscis and siphon are white with pale cloudings of brown. The head is small, the tentacles short and slender, eyes small and black; the sole of the foot is finely spotted with brown. The radula (Fig. 29) as in *Mitra* s.str. (Bayer, 1942).

Dibaphimitra appears to be an ancestral stock of *Dibaphus;* the columellar folds are less numerous and more prominent, the aperture is wider and the shell lighter and more inflated in *Dibaphimitra. Dibaphimitra* possibly spread from Europe to the Indian Ocean and the Caribbean, where one Recent species, i.e. *Mitra florida* survives. The Recent Indo-Pacific species *Mitra rossiae* Reeve, 1844, *M.albina* A. Adams, 1853, and *M.gilbertsoni* (J. Cate, 1968), could be tentatively referred to this genus. *Mitra albina* A. Adams, could be an earlier name for *M.gilbertsoni.* The type and one other specimen examined are both smaller but more mature than the types of *M. gilbertsoni;* the shell is white under a brown periostracum, being more adult, the aperture is narrower and the labial lip thickened and the sculpture is coarser on early whorls.

GEOGRAPHICAL DISTRIBUTION: Caribbean (Recent).

STRATIGRAPHICAL RANGE: Miocene — Recent.

CHARACTERISTIC SPECIES:

MIOCENE — Europe: *clavata* Bellardi, 1887 (= *apposita* Bellardi, 1887 = *taeniolata* Bellardi, 1887); *transsylvanica* Hoernes & Auinger, 1880. S.E. Australia: *dennanti* Tate, 1889.

PLIOCENE — Indonesia: *bantamensis* Oostingh, 1939.

RECENT — Caribbean: *florida* Gould, 1856 (= *fergusoni* Sowerby, 1874).

SUBGENUS **Dibaphus** Philippi, 1847 (of *Mitra*)

(Plate 3, figs. 9 - 13)

Dibaphus Philippi, 1847, Arch. Naturg., 13 (1): 61. Type species by M *Conus edentulus* Reeve = *Mitra edentula* Swainson, 1823. Recent, Indo-Pacific.

= 1923. *Dipaphus* Dautzenberg & Bouge, J. Conchyl., 67: 159 (nom. null.).

1865. *Mitroidea* Pease, Proc. Zool. Soc. Lond., 33 (2): 514. Type species by M *M. multiplicata* Pease, 1865. Recent.

= 1869. *Mauritia* H. Adams, Proc. Zool. Soc. Lond., 39 (2): 205. Type species by M *M.barclayi* H. Adams, 1869 = *Mitroidea multiplicata* Pease, 1865 (non *Mauritia* Troschel, 1863).

1873. *Plochelaea* Gabb, Proc. Acad. Nat. Sci. Philadelphia, 24: 271. Type species by OD *P.crassilabra* Gabb, 1873. Upper Miocene of Dominica.

Shell moderate in size, 25 - 50mm, elongate ovate to elongate cylindrical or oliviform, spire and protoconch conical, whorls flatly convex; sutures weakly impressed. Smooth, finely spirally striate or prominently corded, axially striate. Aperture longer than spire, very narrow, smooth within; labial lip thickened, inflected centrally and flaring basally, edge of labial lip simple or minutely crenulate. Columella with 6 - 11 small, feebly developed or minute, oblique folds; anterior canal straight or slightly recurved, siphonal notch distinct. Periostracum thin and moderately opaque.

The radula (Fig. 78), is of the same pattern as *Mitra* s.str., and the living animal is also essentially the same. Species of *Dibaphus* are mainly tropical reef dwellers, and are found in coral debris and underneath rocks and coral, in shallow water.

The subgenus contains only 2 Recent and 1 fossil species. *Plochelaea gabbi* Pilsbry & Johnson, 1917, from the Dominican Miocene, is an immature specimen of *P.crassilabra* Gabb. The only fossil record of *Dibaphus* is from Upper Miocene deposits of Dominica.

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific (Recent).

STRATIGRAPHICAL RANGE: Upper Miocene — Recent.

CHARACTERISTIC SPECIES:

MIOCENE — Caribbean: *crassilabra* Gabb, 1873 (= *gabbi* Pilsbry & Johnson, 1917).

RECENT — Indo-Pacific: *edentula* Swainson, 1823 (= *philippi* Crosse, 1858); *multiplicata* Pease, 1865 (= *barclayi* H. Adams, 1869 = *dibaphiformis* Sowerby, 1874 = *loebbeckeanus* Weinkauff, 1887 = *paucilineata* Tinker, 1952).

SUBGENUS **Strigatella** Swainson, 1840 (of *Mitra*)

(Plate 4, figs. 1 - 5)

Strigatella Swainson, 1840, Treat. Malac., pp. 130, 131, 319. Type species by SD (Gray, 1847) *Mitra zebra* Lamarck, 1811 = *Voluta paupercula* Linnaeus, 1758. Recent, Indo-Pacific.

= 1874. *Striyatella* Jickeli, Jahrb. Malak. Gesell., 1: 34 (nom. null.).
= 1954. *Strigilla* Pilsbry & Olsson, Bull. Amer. Paleont., 35 (152): 24 (nom. null.).
= 1959. *Stirigatella* Kira, Col. Ill. shells Japan, 1: 84 (nom. null.).
= 1959. *Strigia* Kira, Coll. Ill. shells Japan, 1: 84 (nom. null.).
= 1963. *Strigatell* Shikama, Sel. shells world col., 1: 92 (nom. null.).
= 1964. *Strigatell* Habe, Shells West Pacif. col., 2: 106 (nom. null.).

Shell small to moderate in size, 5 - 50mm, ovate or elongate ovate, solid; sutures plain or coronate. Smooth, or sculptured with smooth or punctate spiral striae and occasionally granules.

Aperture narrow, smooth within, shorter or longer than spire; labial lip thickened, simple or crenulate, interiorly thickened by a blunt denticle or slight callus swelling. Columella with 3 - 5 oblique folds, siphonal canal moderately short. Periostracum moderately thick or thin.

The animal has generally a light coloured sole of the foot, while the dorsum is light or dark brown, and the foot, siphon, tentacles and eyes are similar to those of other Mitrinae.

The radula (Fig. 66) is slightly modified, the laterals are more cleaver-shaped and denticles are generally missing on the last one-third of the lateral plate. A strigatelliform type of radula occurs in species of *Nebularia* (i.e. *Mitra luctuosa* A. Adams and *M.aurantia* Gmelin), while strigatelliform shells may have a typically mitriform radula (i.e. *M.auriculoides* Reeve, and *M.colombelliformis* Kiener). Egg capsules are claviform and similar to *Mitra* s.str.

All the known species of *Strigatella* inhabit the Indo-Pacific region, the sole exception is *Mitra tristis* Broderip, from the Eastern Pacific. *Strigatella* species are rock and reef dwellers, and are occasionally dredged in moderately deeper water on a coral rubble substratum.

Geographical distribution: Indo-Pacific and Eastern Pacific.

Stratigraphical range: Miocene — Recent.

Characteristic species:

MIOCENE — Caribbean: *mesolia* Pilsbry & Johnson, 1917. Indonesia: *bomasensis* Martin, 1916.

RECENT — Indo-Pacific: *acuminata* Swainson, 1824 (= *lutea* Quoy & Gaimard, 1833); *auriculoides* Reeve, 1845 (= *unifascialis* Kiener, 1838 = *assimilis* Pease, 1868); *colombelliformis* Kiener, 1838 (= *columbellaeformis* Reeve, 1844 = *striata* Gray, 1839 = *stutschburyi* Mörch, 1852); *decurtata* Reeve, 1844; *fastigium* Reeve, 1845 (= *discolor* Küster, 1840 = *fuscescens* Pease, 1860 = *brunnea* Pease, 1868); *litterata* Lamarck, 1811 (= *bizonalis* Lamarck, 1822 = *hebraea* Lamarck, 1822 = *leopardina* Küster, 1839 = *anaiis* Lesson, 1842 = *maculosa* Reeve, 1844 = *inversicolor, major, minor,* all Dautzenberg & Bouge, 1923); *paupercula* Linnaeus, 1758 (= *venosa* Röding, 1798 = *zebra* Lamarck, 1811 = *radiata* Schumacher, 1817 = *lineata* Swainson, 1840 = *obtusata* Dautzenberg & Bouge, 1923); *peculiaris* Reeve, 1845; *pellisserpentis* Reeve, 1844 (= *brumalis* Reeve, 1844 = *granata* Reeve, 1844 = *crenilabris* A. Adams, 1853 = *dealbata* A. Adams, 1853 = *grelloisi* Récluz, 1853 = *uzielliana* Crosse, 1861 = *nassoides* Sowerby, 1874 = *minor* Dautzenberg & Bouge, 1923); *pellisserpentis astricta* Reeve, 1844 (= *serotina* A. Adams, 1853 = *samuelis* Dohrn, 1860 = *microstoma* Sowerby, 1874); *pica* Dillwyn, 1817 (= *lineata* Küster, 1841 = *tigrina* A. Adams, 1853 = *jucunda* Tapparone-Canefri, 1876); *rapanuiensis* J. Cate, 1968; *retusa* Lamarck, 1811 (= *virgata* Reeve, 1845 = *tornatelloides* Reeve, 1845 = *amanda* Bartsch, 1918 = *signa* Bartsch, 1919); *saltata* Pease, 1865 (= *alba* Pease, 1868 = *pellucida* J. Cate, 1963); *scutulata* Gmelin, 1791 (= *discolor* Röding, 1798 = *scutellata* Bosc, 1801 = *amphorella* Lamarck, 1811 = *limbifera* Lamarck, 1811 = *strigata* Swainson, 1824 = *sertum* Duval, 1852 = *nebrias* Melvill, 1895); *telescopium* Reeve, 1844; *ticaonica* Reeve, 1844 (= *subrostrata* Sowerby, 1874 = *vagans* Pilsbry, 1921 = *pupiformis* J. Cate, 1963); *turturina* Souverbie, 1875 (= *nivosa* Küster, 1839); *typha* Reeve, 1845 (= *micans* Reeve, 1845 = *tenuis* Sowerby, 1874 = *flexilabris* Sowerby, 1875 = *minor* Sturany, 1903); *vexillum* Reeve, 1844. Eastern Pacific: *tristis* Broderip, 1836 (= *olivacea* Anton, 1839 = *albofasciata* Sowerby, 1874 = *jousseaumiana* Mabille, 1898 = *dolorosa* Dall, 1903 = *salinasensis* Bartsch, 1928).

Genus **Paleofusimitra** Sohl, 1963

(Plate 4, figs. 6 - 7)

Paleofusimitra Sohl, 1963, J. Paleont., 37 (4): 750. Type species by OD *P.elongata* Sohl, 1963. Upper Cretaceous of S.E. United States.

Shell moderately small, 20 - 35mm, fusiform and elongate, teleoconch of *c.* 7 flatly convex whorls, protoconch of 2½ smooth whorls, initial whorl nipple like. Sculptured with spiral striae at sutures, and oblique spiral cords on lower half of the body whorl; early whorls obsoletely costate. Aperture about equal in height to the spire, narrow, constricted anteriorly, smooth within; labial lip thin and simple. Columella with 2 weak and distant folds, anterior fold situated on angular part of columella; siphonal canal produced, narrow and spout shaped, probably lacking a siphonal notch.

The genus is monotypic and represented only by the type species. *Paleofusimitra* is the most primitive mitrid genus still retaining some fasciolarid features. The outline of the columella, i.e. the concave parietal wall, almost denticle-like angulation prior to an outward descent, placement of columellar folds and the notchless produced siphonal canal are all reminiscent of the Fasciolariidae rather than the Mitridae. Sohl (1963) omitted to mention the obsolete axial ribs which are visible in the paratype of *P.elongata*. The author considered *Paleofusimitra* to be a possibly ancestral form of the Eocene *Fusimitra*, which lacked body ornament and has more numerous columellar folds. Species of *Fusimitra* when of average size or slightly smaller, are often prominently spirally corded, and only

gerontic individuals shed the spiral cords following expansion of the whorls with growth and filling in of intersticial spaces with shell matter (for illustrations see Harris & Palmer, 1947). The type of ornamentation of *Fusimitra* resembles *Cancilla* more closely. The Mio-Pliocene mitrid subgenus *Eumitra* Tate, from the Austral-Neozelanic region, also has the tendency towards a reduction in the number of the columellar folds; in *Paleofusimitra*, however, the small number of folds is directly connected with the group's fasciolarid ancestry.

GEOGRAPHICAL DISTRIBUTION: S.E. United States (Alabama, Mississippi and Georgia).

STRATIGRAPHICAL RANGE: Ripley formation, Upper Cretaceous; confined to the *Exogyra costata* zone.

GENUS **Charitodoron** Tomlin, 1932

(Plate 4, fig. 8)

Charitodoron Tomlin, 1932, Ann. Sth. African Mus., 30 (2): 167. Type species by OD *C.euphrosyne* Tomlin, 1932. Recent, South Africa.

Shell moderately small, 20 - 35mm, fusiform and elongate or elongate ovate, thin and fragile; teleoconch of 6 - 8 convex whorls, protoconch of 2 - 2½ large, smooth and mamillate nuclear whorls. Sculptured with punctate spiral striae or cords, early whorls axially costate and generally clathrate. Aperture moderately narrow, shorter than the spire, smooth within; labial lip convex, thin and simple. Columella thinly calloused and completely edentulous; siphonal canal straight or recurved, siphonal notch distinct. Colour of shell fawn or yellowish-brown, sometimes with remains of axial orange zones.

The animal is black or very dark brown, with short tentacles and no eyes. The radula (Fig. 79) is of the same pattern as *Mitra*. Rachidians have 5 - 7 cusps, laterals *c.* 10 cusps (Barnard, 1960). Species of *Charitodoron* are mainly deep water inhabitants, and have been recorded from depth of 238 - 1281 metres (130 - 700 fathoms).

Tomlin (1932) assigned *Charitodoron* to the family Buccinidae on conchological grounds, and Thiele (1925) described new species of *Charitodoron* in the genus *Columbella*. Barnard (1959, 1960a), found the radula of 3 *Charitodoron* species to be of the same pattern as *Mitra*, and re-assigned the genus to the Mitridae. *Charitodoron* is the only mitrid genus with an edentulous columella. The group is a small one, and contains only 4 deep water South African species. *Charitodoron pasithea* Tomlin, may be only a form of *C.thalia*, with less prominent sculpture on the early whorls. The two forms of *C.thalia* resemble *Columbella barbara* Thiele, 1925 and *C.helena* Thiele, 1925, from South Africa.

Barnard (1959) remarked that the types of *Charitodoron pasithea* have either remained in the Tomlin collection or became lost in transit during the war. The holotype of *C.pasithea* Tomlin from Cape Point, is in the British Museum (Nat. Hist.) No. A-3434; the dimensions are length 21.0mm, width 8.2mm, height of aperture 9.2mm.

GEOGRAPHICAL DISTRIBUTION: South Africa (Natal - East London).

STRATIGRAPHICAL RANGE: Recent.

CHARACTERISTIC SPECIES:

RECENT — South Africa: *agulhasensis* Thiele, 1925 (= *aglaia* Tomlin, 1932); *euphrosyne* Tomlin, 1932; *pasithea* Tomlin, 1943 (= *bathybius* Barnard, 1959); *thalia* Tomlin, 1932.

GENUS **Dentimitra** Koenen, 1890

(Plate 4, figs. 9 - 11)

Dentimitra Koenen, 1890, Abh. kön. Preuss. geol. Land., 10 (2): 529. Type species by SD (Cernohorsky, herein) *Mitra circumcisa* Beyrich, 1854. Lower Oligocene of Germany.

= *Fusimitra* auctt. (non Conrad, 1855).

= *Conomitra* auctt. (non Conrad, 1865).

1931. *Puruiana* Martin, Weten. Meded. Mijnb. Ned. Indie, No. 18: 19. Type species by M *Mitrolumna(Puruiana) rustica* Martin, 1931. Upper Eocene of Java.

Shell small, 5 - 20mm, fusiformly elongate or fusiformly ovate; teleoconch of 7 - 9 flat-sided or convex whorls, protoconch small and conical, sutures distinct. Smooth, or feebly sculptured with spiral striae and oblique cords on siphonal canal. Aperture moderately open, about equal in height to spire, smooth within; labial lip thin and simple, constricted anteriorly. Columella with 3 - 5 thin or thick folds, folds somewhat distant and oblique, first posterior fold more prominent than second fold; siphonal canal straight, siphonal notch weakly developed.

Species of *Dentimitra* superficially resemble some smooth forms of *Conomitra,* but differ in features of conical protoconch and disposition of columellar folds, i.e. the more prominent and stronger posterior fold. The correct allocation of *Dentimitra* species is often difficult on the basis of poorly drawn figures which do not show all essential features; some of the characteristic species listed may have to be re-assigned when actual specimens are examined, and other species will undoubtedly be added to the genus.

Dentimitra made its appearance during the Paleocene and became extinct during the late Oligocene.

Geographical distribution: Europe; United States; Indonesia.

Stratigraphical range: Paleocene - Oligocene.

Characteristic species:

PALEOCENE — W. & E. United States: *cretacea* Gabb, 1864; *marylandica* Clark, 1895; *pomonkensis* Clark & Martin, 1901.

EOCENE — E. United States: *murietta* Anderson & Hanna, 1925. England: *obesa* Edwards, 1856 (non Reeve, 1844). Indonesia: *columbellaeformis* Martin, 1931; *rustica* Martin, 1931.

OLIGOCENE — Europe: *circumcisa* Beyrich, 1854; *circumfossa* Beyrich, 1854; *impressa* Koenen, 1890 (non Reeve, 1844); *rhenana* Görges, 1940; *tenuis* Beyrich, 1854. S.E. United States: *lintoidea* Aldrich, 1894.

Subfamily Cylindromitrinae Cossmann, 1899

1899. Cylindromitrinae Cossmann, Ess. paléoc. comp., 3: 152 (retention of subfamily name, art. 40 of ICZN).

1929. Cylindrinae Thiele, Handb. syst. Weicht., 1: 341.

The subfamily contains only a single genus, and the diagnosis for the genus is applicable to the subfamily.

Genus Pterygia Röding, 1798

(Plate 4, figs. 12 - 14 and Plate 5, figs. 1 - 2)

Pterygia Röding, 1798, Mus. Bolten., p. 51. Type species by SD (Dall, 1915) *P.nucella* Röding, 1798 = *Voluta dactylus* Linnaeus, 1767. Recent, Indo-Pacific.

= *Dactylus* auctt. (non Schumacher, 1817).

= 1882. *Pterigia* Bucquoy, Dautzenberg & Dollfus, Moll. mar. Roussillon, 1 (3): 71 (nom. null.).

= 1963. *Ptriegia* Shikama, Sel. shells world col., 1: pl. 74, fig. 16 (nom. null.).

1817. *Cylindra* Schumacher, Ess. nouv. syst., pp. 71, 236. Type species by M *C.coronata* Schumacher, 1817 = *Voluta crenulata* Gmelin, 1791. Recent. (non *Cylindra* Illiger, 1802).

= 1884. *Cyclindromitra* Fischer, Man. Conchyl., pt. 7: 614 (nom. subst. pro *Cylindra* Schumacher, 1817).

= 1895. *Cylinder* Melvill & Standen, J. Conch., 8 (4): 103 (nom. null.) (non *Cylinder* Montfort, 1810).

= 1955. *Cylindrina* Risbec, J. Conchyl., 95 (2): 72 (nom. null.) (non *Cylindrina* Schlüter, 1838).

1929. *Acuticylindra* Iredale, Mem. Queensland Mus., 9 (3): 287. Type species by M *A.nucea* Gronow = *Voluta nucea* Gmelin, 1791. Recent.

Shell moderate in size, 20 - 60mm, fusiformly elongate to cylindrically ovate, solid; teleoconch of 5 - 8 flatly convex or subangulate whorls, protoconch of 1½ - 3 smooth, glassy, white nuclear whorls, initial turn occasionally in the form of a small nipple. Sculptured with spiral striae or ridges and axial growth striae; early whorls occasionally granulose. Aperture narrow, longer than spire, smooth within; labial lip thickened, simple or crenulate. Columella with 5 - 10 oblique and close-set folds, siphonal canal straight, siphonal notch distinct. Periostracum thin but opaque.

The living animal has generally a large foot, short tentacles, a long and slender proboscis, but a small buccal mass. The radula (Figs. 80 - 82) has a formula of 0-1-0. *Pterygia* is the only genus which lacks lateral teeth, and the rachidians have 5 - 9 sharp cusps. The odontophore is short, ranging from 3 - 7% of shell length.

Species of *Pterygia* are shallow water sand-dwellers and are confined to the Indo-Pacific region. *Pterygia* species resemble *Dibaphus* and *Dibaphimitra* in shell features, and it is probable that *Pterygia* evolved from either stock in comparatively recent times. The radula of *Pterygia* is considered more specialized through the loss of lateral teeth.

Mitra melvilli Sowerby, 1882, shares certain features with *Dibaphimitra*, and future radula examination may necessitate a transfer of the species to the Mitrinae.

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific.

STRATIGRAPHICAL RANGE: Pliocene — Recent.

CHARACTERISTIC SPECIES:

PLIOCENE — Indonesia and Okinawa: *crenulata* Gmelin, 1791.

RECENT — Indo-Pacific: *arctata* Sowerby, 1874; *conus* Gmelin, 1791 (= *conoidea* Röding, 1798 = *conulus* Lamarck, 1811); *crenulata* Gmelin, 1791 (= *coronata* Schumacher, 1817 = *undulosa* Reeve, 1844 = *radula* Sowerby, 1874 = *elongata* Hirase, 1908 = *fastidiosa* Iredale, 1929 = *toleranda* Iredale, 1929); *dactylus* Linnaeus, 1767 (= *spuria* Gmelin, 1791 = *nucella* Röding, 1798 = *obesa* Reeve, 1844); *fenestrata* Lamarck, 1811 (= *glans* Reeve, 1844); *melvilli* Sowerby, 1882 (= *hayashii* Kira, 1959); *nucea* Gmelin, 1791 (= *olivaria* Lamarck, 1811 = *zebra* Anton, 1839); *potensis* Montrouzier, 1858 (= *nux* Sowerby, 1874); *pudica* Pease, 1860 (= *nuxavellana* Dohrn, 1860 = *lifouana* Crosse, 1872 = *subtexturata* Garratt, 1880); *scabricula* Linnaeus, 1758 (= *sphaerulata* auctt., = *scabriuscula* Linnaeus, 1767 = *texturata* Lamarck, 1811 = *radiatum* Wood, 1828); *sinensis* Reeve, 1844 (= *lima* Sowerby, 1874).

SUBFAMILY IMBRICARIINAE Troschel, 1867

1867. Imbricariinae Troschel, Geb. Schnecken, 1: 86 (nom. corr. Gill, 1871 — ex Imbricarina).

1871. Imbricariinae Gill, Smiths. Misc. Coll., No. 277: 5 (nom. corr.).

Shell small to large, 12 - 130mm, fusiformly elongate, elongate ovate or conical; teleoconch of up to 10 convex, concavo-convex or angulate whorls, protoconch of 1½ - 3 smooth, glassy, conical nuclear whorls. Sculptured with smooth or beaded, elevated or depressed spiral cords, which may be either close set or distant; species of some genera only spirally striate. Axial riblets or growth striae either prominent or obsolete, presutural ramp often keeled. Aperture shorter or longer than spire, narrow, always smooth within; labial lip thin or thick, simple, bluntly crenulate or crimped, columella with 3 - 10 oblique folds. Siphonal canal short or long, straight or recurved, siphonal notch distinct. Periostracum thin and translucent or moderately thick and opaque.

The living animal is similar to *Pterygia*. The radular formula is 1-1-1, rachidians with 1 - 30 cusps, laterals with 3 - 30 cusps. The most primitive radula can be found in *Domiporta*, the most specialized one in *Scabricola* and to a lesser extent in *Neocancilla*. Egg capsules are claviform or "banana" shaped.

Imbricariinae are exclusively sand dwellers; the majority of species inhabit shallow waters of the intertidal region, and are found buried in coralline or muddy sand; some species have been dredged as deep as 567 metres (310 fathoms).

The subfamily contains 6 Recent genera and 2 subgenera and 1 fossil genus and 2 subgenera, nominate subgenera excluded. The arrangement of the genus-groups *Pseudocancilla, Subcancilla, Ziba, Cancilla* and *Domiporta* is only tentative; the radulae of the type species of *Cancilla* and *Ziba* remains unknown and several chronological priorities must be considered should radula features agree or disagree with the other related genera.

GEOGRAPHICAL DISTRIBUTION: East & West Atlantic; Caribbean; Eastern Pacific; Indo - Pacific; Australia.

STRATIGRAPHICAL RANGE: Upper Cretaceous — Recent.

Genus Imbricaria Schumacher, 1817

(Plate 5, figs. 3 - 6)

Imbricaria Schumacher, 1817, Ess. nouv. syst., pp. 71, 236. Type species by M *I.conica* Schumacher, 1817 = *Mitra conularis* Lamarck, 1811. Recent.

= 1821. *Conoelix* Swainson, Zool. Illust., ser. 1, 1: pl. 24. Type species by OD *C.lineatus* Swainson, 1821 = *Mitra conularis* Lamarck, 1811.
= 1825. *Conohelix* Swainson in Sowerby, Cat. coll. Tankerville, p. 29 (nom. null.).
= 1832. *Conehelix* Deshayes in Guérin, Mag. Zool., pl. 7 (nom. null.).
= 1836. *Conalix* Jay, Cat. rec. shells, p. 63 (nom. null.).
= 1838. *Concelix* Kiener, Spéc. gén. icon. coq. viv., p. 2.
= 1839. *Conelix* Kiener, Spéc. gén. ico. coq. viv., p. 109 (nom. null.).
= 1840. *Conoehelix* Swainson, Treat. Malac., pp. 127-129, 132 (nom. null.).
= 1875. *Conalex* Paetel, Fam. Gatt. Mollusk., p. 50 (nom. null.).
= 1875. *Conolix* Paetel, Fam. Gatt. Mollusk., p. 53 (nom. null.).
= 1966. *Imdricaria* Habe & Kosuge, Shells world col., 2: 73 (nom. null.).

Shell small, 10 - 30mm, conical or oliviform, solid; teleoconch of 5 - 9 convex or subangulate whorls, protoconch of $1\frac{1}{2}$ - 3 glassy nuclear whorls. Smooth, or sculptured with punctate spiral grooves and occasionally axial plicae on early whorls; in some species sculpture scabrous. Aperture narrow, moderately straight, longer than spire, smooth within; labial lip thickened and simple. Columella with 5 - 8 sharply cut oblique folds, parietal wall occasionally with a white callus; siphonal canal straight and short, siphonal notch distinct. Periostracum thin and translucent.

The animal of the type species has a light grey foot which is flecked with white; the siphon is black, with a white longitudinal centre line flanked by two white spots. Tentacles are white, flecked with grey, eyes are black and well developed.

The radula is a modified *Subcancilla* pattern. The rachidians have two, rarely three large main cusps and up to 8 smaller side denticles. Laterals are equipped with 1 large, inward - pointing cusp with a variable number of smaller accessory denticles. In some species only a single large cusp remains on laterals, and the plate is otherwise bare. The egg capsules are cream coloured and ovoid (see Orr-Maes, 1967).

Species of *Imbricaria* are shallow water sand dwellers. *Imbricaria, Subcancilla* and *Scabricola* appear to be closely related, and probably diverged during the late Oligocene from a common ancestor. The species *Scabricola padangensis* (Thiele), resembles a *Subcancilla* and *Imbricaria olivaeformis* (Swainson) could be mistaken for a *Swainsonia,* while *Imbricaria vanikorensis* (Quoy & Gaimard) shows affinities in shell and radula with *Scabricola.*

The age of the deposits on the Chilean Island of Chiloé, from which *Imbricaria chiloensis* (Philippi) has been described, could be either late Miocene or early Pliocene.

Geographical distribution: Indo-Pacific and West Africa (Recent).

Stratigraphical range: Miocene — Recent.

Characteristic species:

? U. MIOCENE — W. coast Sth. America: *chiloensis* Philippi, 1887.

PLEISTOCENE — Europe: *carbonacea caterinii* Meneghini, 1868 (= *mochii* Blanc, 1934).

RECENT — West Africa: *carbonacea* Hinds, 1844 (= *citrina* Reeve, 1844 = *rollandi* Bernardi, 1853). Indo-Pacific: *conovula* Quoy & Gaimard, 1833 (= *virgo* Broderip, 1836 = *eburnea* Philippi, 1850); *conularis* Lamarck, 1811 (= *conica* Schumacher, 1817 = *lineatus* Swainson, 1821 = *decorata* Defrance in Blainville, 1824 = *marmorata* Schubert & Wagner, 1829 = *swainsonii* Lesson, 1831 = *crouani* Crosse, 1868); *olivaeformis* Swainson, 1821 (= *dactyloidea* Anton, 1839 = *olivellaeformis* Pilsbry, 1921); *punctata* Swainson, 1821 (= *truncata* Kiener, 1838 = *ossea* Reeve, 1844); *vanikorensis* Quoy & Gaimard, 1833 (= *deburghiae* Sowerby, 1879 = *isomeres* Melvill & Sykes, 1897).

Subgenus Sohlia nov. subgen. (of *Imbricaria*)

(Plate 5, fig. 7)

Type species here designated *Mitra conoidea* Matheron, 1843. Upper Cretaceous of France.

Shell moderately small, *c.* 26mm, slender and conoidal, spire short and concave, teleoconch of about 5 whorls, body whorl convex at shoulder. Smooth, sculptured with fine spiral striae only. Aperture narrow, longer than spire, smooth within; labial lip thin and simple. Columella with 3 oblique folds which are set fairly low on the columella; siphonal canal straight, siphonal notch moderately shallow. Size of the unique type specimen, length 26.0mm, width 10.0mm.

The type species is the most ancient *Imbricaria* on record and is similar in many features to the Recent *Imbricaria conularis* (Lamarck); the columellar folds in *Sohlia* are fewer in number and are placed rather low on the columellar pillar. There is an appreciable time gap between *Sohlia* and *Imbricaria*, and intermediate records between the Upper Cretaceous and Upper Miocene are unknown. Because of the close similarity between the Cretaceous and Recent species, *Sohlia* is considered a subgenus of *Imbricaria*, despite the considerable time lapse in records and distribution. The type species, from Port de Figuiéres, Turonian of France, appears to be the only record of *Sohlia* so far.

The subgenus is named for Dr. Norman Sohl, U.S. Geological Survey, U.S. National Museum, Washington, in acknowledgement for his contributions to the Cretaceous paleontology of the United States.

Genus Scabricola Swainson, 1840

(Plate 5, figs. 8 - 13)

Scabricola Swainson, 1840, Treat. Malac., pp. 130, 131, 319. Type species by SD (Gray, 1847) *Mitra serpentina* Lamarck.

1811 = *Voluta variegata* Gmelin, 1791. Recent.
= 1842. *Scabricula* Sowerby, Conch. Man., p. 251 (nom. null.).
= 1847. *Scabicola* Gray, Proc. Zool. Soc. Lond., 17 (15): 141 (nom. null.).
= 1876. *Scaricola* Brazier, Proc. Linn. Soc. N.S.W., 1(3): 208 (nom. null.).
= 1966. *Scabricopa* Habe & Kosuge, Shells world col., 2: 78 (nom. null.).

Shell small to moderate in size, 7 - 60mm, elongate ovate to cylindrically ovate, solid; teleoconch of 5 - 8 convex or subangulate whorls, protoconch of 2 - 3 smooth, glassy nuclear whorls. Sculptured with deep, punctate or striate grooves or spiral cords; in some specimens sculpture most prominent on presutural ramp of body whorl and scabrous on earlier whorls. Aperture equal in height or longer than the spire, moderately narrow, smooth within; labial lip moderately thickened, convex or straight, edge finely crenulate or crimped. Columella with 4 - 6 prominent, oblique and close-set folds; siphonal canal short, calloused anteriorly, siphonal notch distinct. Periostracum thin and translucent.

The buccal mass in *Scabricola* is moderately large for Mitridae, and on the average 17% of total shell length. Rachidians are more or less triangular, and have 6 - 8 long, slender and deeply rooted cusps; in one species the rachidian is unicuspid. Laterals are equal in size or only slightly larger than rachidians, and equipped with 3 - 5 strong cusps on the inward facing angular plate. The odontophore is rusty-brown in colour, the last half of laterals is white and thin.

Species of *Scabricola* are shallow water sand dwellers, but are occasionally dredged in moderately deeper water. *Scabricola* is probably a Miocene offshoot of *Imbricaria*.

Geographical distribution: Indo-Pacific.

Stratigraphical range: Miocene — Recent.

Characteristic species:

MIOCENE — Indonesia: *molengraaffi* Martin, 1916.

PLIOCENE — Indonesia: *desetangsii* Kiener, 1838. New Hebrides: *praaevariegata* Abrard, 1946.

RECENT — Indo-Pacific: *alabaster* Sowerby, 1900 (= *sibuyanensis* Sowerby, 1914); *caerulea* Reeve, 1844; *coriacea* Reeve, 1845; *desetangsii* Kiener, 1838 (= *variegata* Reeve, 1844 = *suffecta* Dautzenberg & Bouge, 1923); *eximia* Thiele, 1925; *variegata* Gmelin, 1791 (= *rufum* Röding, 1798 = *serpentina* Lamarck, 1811 = *marquesana* A. Adams, 1853); *vultuosa* Reeve, 1845 (= *laeta* A. Adams, 1853).

SUBGENUS Swainsonia H. & A. Adams, 1853 (of *Scabricola*)

(Plate 5, fig. 14 and Plate 6, figs. 1 - 2)

Swainsonia H. & A. Adams, 1853, Gen. Rec. Moll., 1: 180. Type species (art. 67i of ICZN) *Mitra fissurata* Lamarck, 1811. Recent. (nom. subst. pro *Mitrella* Swainson, 1831).

= 1831. *Mitrella* Swainson, Zool. Illust., ser. 2, 2: pl. 54. Type species by SD (Gray, 1847) *Mitra fissurata* Lamarck, 1811 (misspelled *M.fissuella* and *M.fissurella* by Swainson, 1831) (non *Mitrella* Risso, 1826).

Shells of the subgenus resemble those of *Scabricola,* but are generally more slender and have a smooth appearance. The sculpture is confined to the early whorls and the presutural ramp of the body whorl; the lower two-thirds of the body whorl are smooth apart from punctate spiral grooves. In some species of the subgenus, the oblique folds are positioned fairly low on the columellar pillar.

The radula of *Swainsonia* (Fig. 110) is the same as that of *Scabricola,* and species of *Swainsonia* also live buried in coral sand and coral rubble.

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific.

STRATIGRAPHICAL RANGE: Recent.

CHARACTERISTIC SPECIES:

RECENT — Indo-Pacific: *bicolor* Swainson, 1824 (= *filum* Wood, 1828); *casta* Gmelin, 1791 (= *matronalis* Schumacher, 1817 = *bicolor* Defrance in Blainville, 1824 = *laevis* A. Adams, 1853 = *fasciata* Chenu, 1859); *fissurata* Lamarck, 1811; *fusca* Swainson, 1824 (= *limata* Reeve, 1845 = *formosa* Pease, 1868 = *zephyrina* Sowerby, 1874 = *nevillei* Sowerby, 1874); *newcombii* Pease, 1869; *ocellata* Swainson, 1831 (= *incisa* Adams & Reeve, 1850 = *mariae* A. Adams, 1853).

GENUS Pseudocancilla Staadt in Cossmann, 1913

(Plate 6, fig. 3)

Pseudocancilla Staadt in Cossmann, 1913, Ann. Soc. Roy. Zool. Malac. Belgique, 49: 194. Type species by OD *Mitra* (*Pseudocancilla*)*restifera* Staadt in Cossmann, 1913. Upper Paleocene of France.

Shell moderately small, *c.* 18mm, fusiformly elongate; teleoconch of 7 convex whorls, protoconch of 2 small and smooth nuclear whorls. Sculptured with spiral and bisecting axial cords giving the shell a clathrate appearance. Aperture narrow, equal in height or shorter than the spire, smooth within; labial lip convex, thin and simple, constricted anteriorly. Columella with 8 - 9 small, sharp and equidistant folds, siphonal canal recurved.

Pseudocancilla is similar in form and sculpture to some recent *Subcancilla* species, particularly the species *Subcancilla juttingae* (Koperberg) of the Indonesian Miocene, and the recent *S.verrucosa* (Reeve) and *S.abyssicola* (Schepman). The columellar folds are more numerous, serrated, hardly discernible and differently arranged in *Pseudocancilla* than in the Recent *Subcancilla.*

Cossmann (1913) included 2 species from the Montian of Belgium in the genus *Pseudocancilla,* i.e. *Mitra omalii* Briart & Cornet, 1871, and *M.dewalquei* Briart & Cornet, 1871. These species are more squat than *Pseudocancilla restifera,* the body whorl is large, the spire short and conoidal and the axial riblets more prominent than the spiral cords; these two species have more the appearance of *Conomitra* than *Pseudocancilla.*

GEOGRAPHICAL DISTRIBUTION: Europe (France).

STRATIGRAPHICAL RANGE: Upper Paleocene.

GENUS Subcancilla Olsson & Harbison, 1953

(Plate 6, figs. 4 - 7)

Subcancilla Olsson & Harbison, 1953, Acad. Nat. Sci. Philadelphia Mon., No. 8: 190. Type species by OD *Mitra sulcata* Swainson = *Mitra sulcata* Swainson in Sowerby, 1825. Recent, Eastern Pacific.

= *Tiara* auctt. (non Swainson, 1831).

= *Cancilla* (pars) auctt.

= 1969. *Taira* Shuto, Mem. Fac. Sci. Kyushu Uni, Geol., 19 (1): 164 (nom. null.).

Shell small to moderate in size, 15 - 100mm, fusiformly ovate to fusiformly elongate; teleoconch of 7 - 10 convex and angulate whorls, protoconch of 2 - 3 smooth, glassy nuclear whorls. Sculptured with elevated, occasionally grooved spiral cords, axial striae in interstices or bisecting longitudinal lirae. Aperture narrow, often fusiform, equal in height or longer than the spire, smooth within; labial lip moderately thin, bluntly undulate or crimped, sometimes constricted anteriorly. Siphonal canal short or slightly produced, straight or slightly recurved, siphonal notch distinct. Periostracum moderately thin, opaque or translucent.

The living animal is similar to *Imbricaria*, the foot and siphon are moderately large, the tentacles are short. The radula (Figs. 86 - 92) has the formula 1-1-1, the rachidians are wider than they are high, the 2 central cusps are long and slender and the accessory cusps are appreciably smaller. Laterals are humped but narrow towards the end of the plate, one frontal cusp is unusually large, others appreciably smaller. The buccal mass is very small, the length of the odontophore generally averaging 5 - 7% of shell length. Egg capsules are claviform.

Subcancilla species are sand dwellers, and inhabit sand bars and pockets of coral sand of tropical reefs. Some species are confined to deeper water, and have been recorded from a mud and coral rubble substratum to a depth of 567 metres (310 fathoms).

The radula of *Cancilla* is unknown, and the relationship to *Subcancilla* cannot be properly evaluated at this time. The radula of *Subcancilla* has a distinctive pattern not found in any other mitrid genus, with the possible exception of *Imbricaria* which it resembles in some features.

The genus group name *Tiara* as used by some writers (Woodring, 1964; Shuto, 1969), is not applicable to the *Subcancilla* or *Cancilla* group of species. Gray's designation (1847) of *Mitra corrugata* Lamarck, 1811 (= *Vexillum rugosum* Gmelin, 1791), an originally included species, is prior to Herrmannsen's designation (1849) of *Tiara isabella* Swainson. *Tiara* is therefore a subjective synonym of *Vexillum* Röding, 1798, in the subfamily Vexillinae.

Some *Subcancilla* species, i.e. *S.bacillum* (Lamarck), *S.fulgetrum* (Reeve) and *S.flammea* (Quoy & Gaimard), have a modified radula intermediate in characters between *Mitra* and *Subcancilla*. The rachidians in these species are typically mitrid in character, while the laterals lack the small cusps anteriorly to the inward pointing large cusp, which is appreciably smaller than in the typical *Subcancilla* radula. A future classification of these species in *Ziba* may be more appropriate.

The presence or absence of intersticial intermediate spiral cords is a variable character not applicable for diagnostic purposes. In species which normally have primary spiral cords only, the appearance of individuals with intermediate secondary spirals is not at all unusual; some specimens may develop extra spirals between one or two main spirals only.

GEOGRAPHICAL DISTRIBUTION: Eastern Pacific; Indo-Pacific.

STRATIGRAPHICAL RANGE: Miocene — Recent.

CHARACTERISTIC SPECIES:

MIOCENE — Caribbean: *dalli* Engerrand & Urbina, 1910; *dariensis* Brown & Pilsbry, 1911 (= *colombiana* Weisbord, 1929 = *venezuelana* Hodson in Hodson & Hodson, 1931); *desmia* Gardner, 1937; *henekeni* Sowerby, 1850 (= *sanctifrancisci* Maury, 1925); *illacidata* Woodring, 1928; *longa longa* Gabb, 1873; *longa couvensis* Maury, 1925; *longa rhadina* Woodring, 1928; *mitrodita* Gardner, 1937; *senecta* White, 1887; *silicata* Dall, 1890. Indonesia: *gerthi* Pannekoek, 1936; *juttingae* Koperberg, 1931; *sokkohensis* Martin, 1916. Fiji: *malleti fijiensis* Ladd, 1934; *nasongoensis* Ladd, 1934.

PLIOCENE — Eastern Pacific: *ecuadoriana* Olsson, 1964; *gigantea* Reeve, 1844; *musa* Olsson, 1964; *sulcata* Swainson, in Sowerby, 1825. Indonesia: *abyssicola* Schepman, 1913 (= *osapiensis* Koperberg, 1931); *annulata* Reeve, 1844 (= *mantjeuriensis* Oostingh, 1939); *interlirata* Reeve, 1844; *juttingae* Koperberg, 1931. Philippines: *interlirata* Reeve, 1844. Fiji: *abyssicola* Schepman, 1913.

RECENT — Eastern Pacific: *attenuata* Broderip, 1836 (= *hindsii* Reeve, 1844 = *directa* Berry, 1960); *gigantea* Reeve, 1844 (= *polystira* Pilsbry & Olsson, 1941); *lineata* Broderip, 1836 (= *erythrogramma* Tomlin, 1931 = *calodinota* Berry, 1960); *sulcata* Swainson in Sowerby, 1825 (= *funiculata* Reeve, 1844 = *haneti* Petit de la Saussaye, 1852). Indo-Pacific: *annulata* Reeve, 1844 (= *nitens* Kiener, 1838 = *acutilirata* Sowerby, 1874 = *acuta* Sowerby, 1879 *foveolata* Dunker, 1858 = *pia* Dohrn, 1861 = *novaehollandiae* (pars) Sowerby, 1874 = *hidalgoi* Sowerby, 1913 Petit de la Saussaye, 1852 (= *insculpta* A. Adams, 1853 = *"circula"* Cernohorsky, 1965); *verrucosa* Reeve, 1845 (= *hystrix* Montrouzier, 1862).

Genus Ziba H. & A. Adams, 1853

(Plate 6, figs. 8 - 12)

Ziba H. & A. Adams, 1853, Gen. Rec. Moll., 1: 179. Type species by SD (Wenz, 1943) *Mitra(Ziba)carinata* Swainson = *Mitra carinata* Swainson, 1824. Recent, W. Africa.

= 1880. *Zeba* Garrett, J. Conch., 3: 73 (nom. null.).

= 1881. *Zeba* Martens, Zool. Record, 17: 49 (nom. null.).

Shell moderately small, 15 - 35mm, elongate fusiform; teleoconch of 7 - 8 angulate or convex whorls, protoconch of 2 - 2½ smooth, glassy nuclear whorls. Sculptured with a presutural carina, spiral grooves and axial lirae in interstices; spiral grooves sometimes confined to the presutural ramp and base of the body whorl, or quite distinct along the entire length of the last whorl. Aperture narrow, fusiform, longer than the spire, smooth within; labial lip slightly thickened, simple or bluntly crimped. Columella with 3 - 5 oblique folds, siphonal canal straight, siphonal notch distinct. Periostracum brown in colour.

The radula of the type species is unknown, and the relationship of *Ziba* to either *Subcancilla* or *Cancilla* remains obscure. In shell form, *Ziba* resembles *Subcancilla,* in sculpture it leans towards *Cancilla.* The radula of the Indo-Pacific species tentatively assigned to *Ziba* is of a modified *Subcancilla* pattern; the rachidians are of a mitrid pattern, while the laterals are intermediate in characters between *Mitra* and *Subcancilla.* Should the radula of *Ziba* prove to be similar in pattern to *Subcancilla,* then the latter genus would be reduced to a subgenus of the former. If, however, *Ziba* is more closely related to *Cancilla,* which I think is unlikely, then *Ziba* can be retained as a subgenus of *Cancilla:*

The type species lives in moderately shallow water, and has been dredged to a depth of 20 metres (11 fathoms). The Indo-Pacific species tentatively assigned to *Ziba* are shallow water sand dwellers.

Geographical distribution: West Africa; S.E. Atlantic; tentatively Indo-Pacific (Recent).

Stratigraphical range: Miocene — Recent.

Characteristic species:

MIOCENE — Europe: *bronni* Michelotti, 1847; *cochlearella* Mayer-Eymar, 1891; *goniophora* Bellardi, 1850; *praenigra* Mayer-Eymar, 1891.

PLIOCENE — Europe: *bronni* Michelotti, 1847; *fusulus* Cocconi, 1873.

RECENT — West Africa and S.E. Atlantic: *carinata* Swainson, 1824 (= *senegalensis* Reeve, 1844 = *gambiana* Dohrn, 1861); *turtoni* E. A. Smith, 1890 (= *exilima* Locard, 1897 = *minor* Locard, 1897). Indo-Pacific (tentative): *astyagis* Dohrn, 1860 (= *bacillum* Reeve, 1844); *bacillum* Lamarck, 1811 (= *philippinarum* A. Adams, 1853 = *fischeri* Souverbie, 1860 = *semiconica* Sowerby, 1874 = *strigillata* Sowerby, 1874); *flammea* Quoy & Gaimard, 1833 (= *intersculpta* Sowerby, 1870); *fulgetrum* Reeve, 1844 (= *boissaci* Montrouzier, 1858 = *cyri* Dohrn, 1861); ? *rehderi* Webb, 1958.

Genus Cancilla Swainson, 1840

(Plate 6, figs. 13 - 16 and Plate 7, figs. 1 - 2)

Cancilla Swainson, 1840, Treat. Malac., pp. 130, 320. Type species by SD (Herrmannsen, 1846) *Tiara isabella* Swainson, 1831. Recent, Indo-Pacific.

= *Tiara* auctt.

= 1847. *Cancella* Gray, Proc. Zool. Soc. Lond., 17: 142 (nom. null.).

= 1867. *Caucilla* Angas, Proc. Zool. Soc. Lond., pp. 110, 117 (nom. null.).

= 1880. *Cancilia* Hoernes & Auinger, Abh. k. k. geol. Reichsanst., 12 (2): pl. 9 (nom. null.).

= 1898. *Canilla* Jousseaume, Le Naturaliste, 12 (268): 106 (nom. null.).

Shell moderately small to large, 20 - 120mm, elongate fusiform; teleoconch of 6 - 10 convex or flat-sided whorls, protoconch of 2 - 3½ smooth, glassy nuclear whorls. Sculptured with close-set, rounded or depressed spiral cords which are more numerous and less angulate than in *Subcancilla,* or occasionally only with shallow spiral grooves; interstices narrow, smooth or ornamented with axial striae. Aperture narrow, fusiform, shorter or longer than spire, smooth within; labial lip moderately thin, convex, edge of labial lip bluntly crimped. Columella with 3 - 6 oblique folds, siphonal canal straight or recurved, sometimes produced, siphonal notch distinct. Periostracum thin and brown in colour or black and opaque.

The radula of the type species of *Cancilla* is unknown, and species have been assigned to the genus on the basis of similarity of conchological characters. *Cancilla* species differ to *Subcancilla* in features of less angulate and more convex whorls, more numerous and less elevated, cord-like spiral threads and narrow interstices. Recent species of *Cancilla* do not live in the intertidal zone, but inhabit moderately deep water; species of *Cancilla* have been recorded from as deep as 200 metres (110 fathoms).

The typical large *Cancilla* s.str. flourished during Miocene times in the European and Caribbean regions. Recent species survive only in West Africa and the east coast of South America, but spread as far as Morocco and India. The first typical *Cancilla* appeared in the Indonesian-Chinese region as late as Pliocene. Apart from one species each in the Southwest and Southeast Atlantic, the large *Cancilla* is confined to the central Indo-Pacific.

GEOGRAPHICAL DISTRIBUTION: West Africa; E. coast of Sth. America; Indo-Pacific.

STRATIGRAPHICAL RANGE: Miocene — Recent.

CHARACTERISTIC SPECIES:

MIOCENE — Europe: *alligata* Defrance in Blainville, 1824 (= *striatula* Brocchi, 1814 = *brochii* Potiez & Michaud, 1838, etc.); *scrobiculata* Brocchi, 1814. Caribbean: *limonensis* Olsson, 1922; *sieversi* Rutsch, 1934; *symmetrica* Gabb, 1873. India: *subscrobiculata* d'Orbigny, 1852 (= *scrobiculata* J. de C. Sowerby, 1840). Indonesia: *aegra junghuhni* Martin, 1880. Okinawa: *loochoensis* MacNeil, 1960; *yonabaruensis* MacNeil, 1960. S.E. Australia: *multisulcata* Harris, 1897.

PLIOCENE — Indonesia, Formosa & Okinawa: *aegra* Reeve, 1845. Philippines: *isabella* Swainson, 1831. Europe: *alligata* Defrance in Blainville, 1824; *scrobiculata* Brocchi, 1814 (also Morocco).

RECENT — West Africa: *scrobiculata crosnieri* Cernohorsky, 1970. Uruguay & Brazil: *larranagai* Carcelles, 1947. Indo-Pacific: *aegra* Reeve, 1845 (= *peasei* Dohrn, 1861 = *yokoyamai* Nomura, 1935); *isabella* Swainson, 1831 (= *morchii* A. Adams, 1855 = *herklotsiana* Dohrn, 1861 = *acuminata* Shuto, 1969).

SUBGENUS **Fusimitra** Conrad, 1855 (of *Cancilla*)

(Plate 7, fig. 3)

Fusimitra Conrad, 1855, Proc. Acad. Nat. Sci. Philadelphia, 7 (7): 261. Type species by SD (Grant & Gale, 1931) *Mitra mellingtoni* Conrad, 1855 = *Mitra conquisita millingtoni* Conrad in Wailes, 1854. Eocene of S.E. United States.

Shell moderately small to large, 20 - 130mm, fusiform and slender, often polished; teleoconch of 6 - 9 convex whorls, protoconch of 3 - 4 smooth, conical nuclear whorls. Sculptured with spiral striae which give rise to flat or rounded spiral cords; spiral sculpture often obsolete particularly in gerontic individuals; the interstices of spiral cords generally axially striate. Aperture narrow, fusiform, shorter or longer than spire, smooth within; labial lip thin, simple, convex, slightly constricted anteriorly. Columella with 3 - 4 oblique folds, siphonal canal slender and produced, siphonal notch generally distinct.

The relationship of *Fusimitra* is with the large *Cancilla* s.str. and not *Mitra*. The sculpture of spiral cords is prominent in specimens up to 60mm, becomes partially obsolete in larger specimens and almost absent in large, old individuals, such as the type species of *Fusimitra*. *Fusimitra* is retained as a subgenus of *Cancilla* for Tertiary species from the continental United States, which are characterized by obsolescence of sculpture with age. The different sculptural variants of *Fusimitra* have been well illustrated by Harris & Palmer (1947). We consider *Mitra millingtoni* Conrad, to be the Eocene ancestral form of the Oligocene *M.conquisita* Conrad; specimens of both forms are separable only stratigraphically.

GEOGRAPHICAL DISTRIBUTION: United States.

STRATIGRAPHICAL RANGE: Mid-Eocene — Mid-Oligocene.

CHARACTERISTIC SPECIES:

EOCENE — S.E., S.W. and E. United States: *conquisita millingtoni* Conrad in Wailes, 1854 (= *subconquisita* de Gregorio, 1890 [Mississippi, Arkansas, Louisiana, N.E. Mexico]. Texas & N.E. Mexico: *neta* Gardner, 1945. California: *uvasana* Dickerson, 1915.

OLIGOCENE — Alabama, Mississippi & N.E. Mexico: *conquisita conquisita* Conrad, 1848 (= *mississippiensis* Conrad, 1848).

SUBGENUS **Domiporta** nov. subgen. (of *Cancilla*)

(Plate 7, figs. 4 - 7)

Type species here designated *Voluta filaris* Linnaeus, 1771. Recent, Indo-Pacific.

Shell small to moderate in size, 15 - 65mm, fusiformly elongate to fusiformly ovate; teleoconch of 5 - 10 convex whorls, protoconch of 1½ - 4 smooth, glassy, white or violet nuclear whorls. Sculptured with finely nodulose spiral cords, moderately deep longitudinal grooves or intersticial axial striae. Aperture shorter or longer than spire, only moderately narrow, smooth within; labial lip thin, crimped on edge, not constricted basally. Columella with 3 - 6 oblique folds, siphonal canal moderately short, siphonal notch distinct. Periostracum thin and translucent.

The radula is unique in pattern, bearing no resemblance to any other mitrid group, and is intermediate in characters between *Mitra* and *Vexillum*. The rachidians have a crescent-shaped base, the denticles are small, thin and pointed, and number from 9 - 32. The shape of the laterals is similar to *Mitra*, but the cusps are not deeply rooted as in *Mitra* and are small, thin and sharp instead; lateral cusps number from 14 - 28. The buccal mass is very small, the odontophore averaging 4% of total shell length. Teeth are numerous, the rows closely set, averaging from 57 - 190 rows of teeth per 1mm of ribbon length; the rachidians are large in comparison to the laterals, and larger than those of *Mitra* or *Subcancilla*. The odontophore is white and thin.

The egg mass of the type species consisted of a cluster of 85 - 90 brown-coloured, "banana"-shaped egg capsules, which measured 3.5 - 4.0mm in height and 1.0 - 1.2mm in width; capsules contained from 130 - 150 cream-coloured spherical eggs 110 - 180μ in diameter.

In shell characters, species of *Domiporta* resemble to some extent *Cancilla* and *Subcancilla*, but species of *Domiporta* in which the radula has been examined share the following features in common: the spiral cords are less elevated than in species of *Subcancilla* and the cords are not smooth but nodulose. The aperture is less narrow than in *Subcancilla* and the whorls are more inflated than in either *Cancilla* or *Subcancilla*. Longitudinal bisecting grooves, which are generally not present in either *Cancilla* or *Subcancilla*, are a prominent feature in *Domiporta* species.

The group of species with the unique type of radula was classed in "group 10" by Cooke (1920) and Peile (1936), and was left unnamed by the writer in his tentative review of the genera of Mitridae (1966d). In view of the unknown identity of the radula of *Cancilla*, *Domiporta* has been tentatively retained as a subgenus of *Cancilla*.

Species of *Domiporta* are shallow water sand dwellers, but a few species have been dredged to a depth of 92 metres (50 fathoms).

GEOGRAPHICAL DISTRIBUTION: Tropical Indo-Pacific; S.E. Australia - Kermadec Ids. region; South Africa.

STRATIGRAPHICAL RANGE: Miocene — Recent.

CHARACTERISTIC SPECIES:

MIOCENE — Indonesia: *carnicolor kannegieteri* Icke & Martin, 1906.

PLIOCENE — Indonesia & Java: *carnicolor* Reeve, 1844; *circula* Kiener, 1838.

RECENT — Indo-Pacific: *carnicolor* Reeve, 1844 (= *pura* A. Adams, 1853 = *millepunctata* Sowerby, 1889); *circula* Kiener, 1838 (= *circulata* Reeve, 1844 = *rufescens* A. Adams, 1853 = *burnupiana* Cooke, 1920); *duplilirata* Reeve, 1845 (= *lalage* Melvill & Standen, 1901); *filaris* Linnaeus, 1771 (= *filosa* Born, 1778 = *nexilis* Lamarck, 1811 = *bernardiana* Philippi, 1850 = *bornii* Philippi, 1850); *gloriola* Cernohorsky, herein (= *gracilis* Reeve, 1844); *granatina* Lamarck, 1811 (= *ehrenbergi* Jickeli, 1874 = *scabricola* Kobelt, 1878 = *sura* Jousseaume, 1898 = *langfordi* Pilsbry, 1921 = *candida* Dautzenberg & Bouge, 1923); *incarnata* Reeve, 1845 (= *reticulata* A. Adams, 1853); *praestantissima* Röding, 1798 (= *gracilis* Philippi, 1850); *rufilirata* Adams & Reeve, 1850. South Africa: *aerumnosa* Melvill, 1888. S.E. Australia & Kermadec Islds.: *strangei* Angas, 1867 (= *franciscana* Tenison-Woods, 1877 = *nodostaminea* Hedley, 1912).

GENUS **Neocancilla** Cernohorsky, 1966

(Plate 7, figs. 8 - 12)

Neocancilla Cernohorsky, 1966, The Veliger, 9 (2): 110 Type species by OD *Voluta papilio* Link, 1807. Recent, Indo-Pacific.

Shell small to moderate in size, 10 - 60mm, fusiformly elongate, solid; teleoconch of 6 - 9 convex or subangulate whorls, protoconch of 2 - 3 smooth, glassy nuclear whorls. Sculpture predominantly decussate and beaded; bisecting spirals and axial grooves giving rise to elongated

fillets or nodules. Aperture moderately narrow, shorter or longer than spire, smooth within; labial lip thickened, crimped or obsoletely crenulate, distinctly angulate anteriorly. Columella calloused anteriorly, and with 4 - 5 prominent oblique folds; siphonal canal short or moderately produced, siphonal notch distinct. Periostracum thin and translucent.

The radula (Fig. 99) of *Neocancilla* differs from other mitrid genera. The rachidians have 2 massive main cusps which are flanked at either side by 1 - 2 overlapping and deeply rooted side cusps; laterals are of modified mitrid shape, stunted and narrow, with only 4 - 6 cusps and 1 - 3 small denticles; the posterior one-half of the plate is often bare.

The animal of the type species has a translucent cream foot which is densely spotted with white; the dorsum of the foot is lined and marbled with brown. Tentacles are short, eyes black and ringed with white; the eyes, proboscis and siphon are moderately well developed. A poison gland is present in *Neocancilla*.

Species of *Neocancilla* live in coral sand and coral rubble, in shallow and deeper water. The genus is exclusively Indo-Pacific and West African, and appears to be a Recent offshoot of *Ziba* H. & A. Adams. Only seven species can be assigned to this genus with certainty.

Geographical distribution: Indo-Pacific; West Africa.

Stratigraphical range: Recent.

Characteristic species:

RECENT — West Africa: *hebes* Reeve, 1845 (= *asperulata* A. Adams, 1853 = *hamillei* Petit de la Saussaye, 1851 = *minor* Locard, 1897). Indo-Pacific: *arenacea* Dunker, 1852 (= *formosa* A. Adams, 1853); *clathrus* Gmelin, 1791 (= *crenifera* Lamarck, 1811 = *tathnae* Jickeli, 1874 = *eburneostoma* Garrett, 1880 = *emersoni* Pilsbry, 1921); *papilio* Link, 1807 (= *leucostoma* Gmelin, 1791 = *scabriuscula* Lamarck, 1811 = *malsburgi* Menke, 1828 = *langfordiana* J. Cate, 1962—*sphaerulata* auctt.); *pretiosa* Reeve, 1844 (= *antoniae* H. Adams, 1870); *takiisaoi* Kuroda & Sakurai in Kuroda, 1959; *waikikiensis* Pilsbry, 1921.

Subfamily Vexillinae Thiele, 1929

1864. Turriculinae A. Adams, J. Linn. Soc. Lond., 7: 200 (for *Costellaria* Swainson, 1840—not available, art. 11c and 63 of ICZN).

1888. Plesiomitrinae Bellardi, Mem. R. Accad. Sci. Torino, 38: 277 (not available, art. 11c and 63 of ICZN).

1899. Pseudomitrinae (pars) Cossmann, Ess. paléoc. comp., 3: 151 (not available, art. 11c and 63 of ICZN).

1899. Semimitrinae Cossmann, Ess. paléoc. comp., 3: 151 (not available, art. 11c and 63 of ICZN).

1929. Vexillinae Thiele, Handb. syst. Weicht., 1: 337.

1961. Pusinae Habe, Col. Illust. shells Japan, 2: 69.

1961. Vexilliinae Habe, Col. Illust. shells Japan, 2: 69.

1964. Pusiinae Habe, Col. Illust. shells Japan, 2: 106.

Shell small to moderate in size, 3 - 80mm, fusiform, slender or ovate; spire elevated, occasionally turreted, sutures distinct, simple or tuberculate, whorls straight or convex. Rarely smooth, generally sculptured with axial ribs, beads, grooves or spiral ridges. Aperture moderately wide or narrow, always lirate within in species of all genera, with the exception of the Cretaceous genus *Mesorhytis* and some species of the Recent *Austromitra*. Labial lip thin or thickened, simple or denticulate; columella often calloused and with 3 - 6 well-developed oblique folds, first posterior fold usually larger than second fold. Parietal wall frequently with a callus pad; siphonal canal straight or recurved, short or long, siphonal notch distinct or moderately shallow. Periostracum thin and translucent.

The animal has a moderately large and multicoloured foot, and long, slender tentacles; eyes and siphon are moderately large, proboscis small. The presence of a poison gland has been confirmed in the genus *Thala*.

The buccal mass is small, the length of the odontophore varies from 3 - 10% of shell length. The radula of the Vexillinae consists of two patterns: the bow-shaped and multicuspid type of rachidian or the concave, cresent-shaped, tri-cuspid rachidian; intermediate rachidians with only 5 and 7 cusps have also been recorded. Recent genus groups of Vexillinae are very closely related and a generic separation on the basis of multicuspid and tricuspid rachidians would produce incongruous results. The radula of the species *V.cancellarioides* (Anton) and *V.luculentum* (Reeve) is typically Vexilline,

i.e. the rachidians are multicuspid, yet the shells have the appearance of *Pusia*. *Vexillum isaoi* (Kuroda & Sakurai in Kuroda, 1959) has Pusiine tricuspid rachidians and a Vexilline shell. Species of the genus *Thala*, a group well defined on shell characters, have a radula with 3, 5 or 7 cusps on the rachidians. The lateral teeth in all Vexilline genera are simple, sickle-shaped and unicuspid. The rachidians of the temperate water genus *Austromitra* are multicuspid.

The correct assignment of some vexilline species will, in some instances, be a matter of interpretation of shell characters and subsequent application of the total sum of diagnostic characters to one group or another. Differences between *Costellaria* and *Pusia* are often nebulous and changes in shell form more gradual than abrupt; characters representing both groups may appear in variants of a single species (see *V.(P.)ebenus* Lamarck). In view of the close relationship of *Costellaria* and *Pusia*, interchangeable radula patterns and common geographical distribution, a classification of *Costellaria* and *Pusia* as subgenera of *Vexillum* is more appropriate.

Vexillinae are predominantly sand dwellers, but a small percentage of species inhabit the underside of rocks and coral boulders and crevices of coral reefs. Vexillinae live in shallow and deep water; some species have been dredged in 924 metres (505 fathoms), on a substrate of mud and broken shale, at temperatures as low as 6°C (43°F).

The prior usage of Turriculidae Carpenter, 1861 and Turriculinae A. Adams, 1864 in the family Mitridae, pre-occupies Turriculinae Powell, 1942 in the family Turridae.

The subfamily contains 4 Recent genera and 2 subgenera and 1 fossil genus, exclusive of nominate subgenera.

Geographical distribution: Cosmopolitan.

Stratigraphical range: Eocene — Recent.

Genus Mesorhytis Meek, 1876

(Plate 7, figs. 13 - 15 and Plate 8, figs. 1 - 3)

Mesorhytis Meek, 1876, Rept. U.S. Geol. Surv. Territ., 9: 356, 364. Type species by M *Fasciolaria(Mesorhytis)gracilenta* Meek, 1876. Upper Cretaceous of S.E. United States.

1963. *Mitridomus* Sohl, J. Paleont., 37 (4): 749. Type species by OD *Fasciolaria ripleyana* Wade, 1926. Upper Cretaceous of S.E. United States.

Shell small to moderate in size, 15 - 40mm, fusiformly elongate; teleoconch of 7 - 10 convex whorls, protoconch of 1½ - 2 paucispiral nuclear whorls, sutures distinct. Sculptured with slender axial ribs and fine spiral striae; axial ribs numbering 15 to 25 on the body whorl, and spiral striae from 25 to 50. Aperture narrow, equal in height or longer than spire, smooth within; labial lip thin and simple, narrowing towards a moderately long siphonal canal. Columella with 3 - 4 oblique folds, siphonal notch shallow.

Mesorhytis is a close relative of the Cretaceous fasciolarid genus *Paleopsephaea* Wade, 1926, a genus widely distributed during the late Cretaceous. Species of *Paleopsephaea* are similar in form and columellar arrangement to *Mesorhytis*, but are slightly more obese, the axial folds are fewer in number and thicker, and whorls are posteriorly more prominently constricted. The large (58mm) species *Paleopsephaea decorosa* Stephenson, 1952, from the Woodbine formation, Cenomanian of Texas, may be referable to *Mesorhytis;* the axial ribs are slender and numerous and the posterior constriction of the whorls is lacking. *Mesorhytis* may conceivably represent the prototypic stock of the Vexillinae, but apart from the axial ribs and spiral striae, there is little else in way of diagnostic characters (e.g. parietal callus pad, labral lirae) to enable a definite association with the Vexillinae. *Mesorhytis* species with a prominent spiral sculpture, bear some resemblance to the Paleocene *Pseudocancilla*.

Mesorhytis obscura Wade, 1926, from the Ripley formation of Tennessee, should be located in the fasciolarid genus *Graphidula* Stephenson, 1941. *Mitra potomacensis* Clark & Martin, 1901, from the Aquian and Nanjemoy formations of Maryland, appears to be a small *Paleopsephaea*. *Mitra gasparini* d'Orbigny, 1843 and *Voluta renauxiana* d'Orbigny, 1842, from the Cretaceous of Europe, are questionable *Mesorhytis*. *Fasciolaria assimilis* Stoliczka, 1868, from the Cretaceous of South India, is a large, 140mm-long fasciolarid. *Mitra waelii* Binkhorst, 1861, from the Cretaceous of Limburg

and *Turricula(Mesorhytis)monilifera* Pethö, 1906, from the Cretaceous of Petervardein, Hungary, are both questionable *Mesorhytis;* the latter species has been described from a shell fragment with 3 columellar folds, showing features of *Paleopsephaea.* The two Recent species *Mesorhytis costatus* Dall, 1890, from deep water off St. Kitts and *M.meekiana* Dall, 1899, from off Cuba, should be referred to the Fasciolariidae.

Mitridomus Sohl, separated from *Mesorhytis* on features of posteriorly constricted whorls, 1 more columellar fold and shorter siphonal canal, is undoubtedly synonymous with *Mesorhytis.* In the family Mitridae, where ecophenotypic, individual and developmental stage variations have an expanded range, these diagnostic characters are of infraspecific importance. The difference in the constriction of the whorls between *Mesorhytis* and *Mitridomus* is one of degree only, and the number of columellar folds is variable within a single species. A portion of the siphonal canal and part of the labial lip are missing in the holotype of *Fasciolaria ripleyana,* and the actual length of the siphonal canal is indeterminable. It is of interest to note that the holotype of *Mesorhytis gracilenta* Meek, does show a fourth columellar fold, under magnification, in the matrix-filled aperture.

GEOGRAPHICAL DISTRIBUTION: Europe; S.E. & N. United States; India.

STRATIGRAPHICAL RANGE: Upper Cretaceous — Paleocene.

CHARACTERISTIC SPECIES:

U. CRETACEOUS — Europe: *cassisiana* d'Orbigny, 1850 (= *cancellata* Sowerby, 1832). India: *arrialoorensis* Stoliczka, 1868; *cassisiana* d'Orbigny, 1850. N. & S.E. United States: *gracilenta* Meek, 1876; *ripleyana* Wade, 1926.

PALEOCENE — Dakota: *dacotensis* Stanton, 1920 (Lance formation).

GENUS **Vexillum** Röding, 1798

(Plate 8, figs. 4 - 9)

Vexillum Röding, 1798, Mus. Bolten., p. 138. Type species by SD (Woodring, 1928) *V.plicatum* Röding, 1798 = *Voluta plicaria* Linnaeus, 1758. Recent, Indo-Pacific.

= 1823. *Turricula* Fabricius & auctt., Fort. Bisk. Fabr. Nat., p. 80. Type species by SD (Coan, 1966) *T.plicaria* = *Voluta plicaria* Linnaeus, 1758 (non *Turricula* Schumacher, 1817).

= 1934. *Turricola* Nardini, Palaeont. Ital. Siena, 34: 196 (nom. null.).

= 1937. *Vexilla* Gardner, U.S. Geol. Surv. Prof. Pap., 142: 416 (nom. null.) (non *Vexilla* Swainson, 1840).

= 1964. *Vexillium* Habe, Shells west. Pacif. col., 2: 108 (nom. null.).

1810. *Turris* Montfort, Conch. Syst., 2: 538. Type species by OD *T.vulpecula* Linnaeus = *Voluta vulpecula* Linnaeus, 1758. Recent. (non *Turris* Röding, 1798).

= 1824. *Vulpecula* Defrance in Blainville, Dic. Sci. Nat., 31: 106. Type species by T *Voluta vulpecula* Linnaeus, 1758. (non *Vulpecula* Jarocki, 1822).

= 1899. *Turricula* Cossmann, Ess. paléoc. comp., 3: 162. Type species by OD *Mitra vulpecula* Linnaeus = *Voluta vulpecula* Linnaeus, 1758. (non *Turricula* Schumacher, 1817; nec Fabricius, 1823).

1831. *Tiara* Swainson, Zool. Illust., ser. 2, 2: pl. 50. Type species by SD (Gray, 1847) *Mitra corrugata* Lamarck, 1811 = *Voluta rugosa* Gmelin, 1791. Recent.

= 1840. *Thiara* Swainson, Treat. Malac., p. 130 (non Röding, 1798) (nom. null.).

1842. *Harpaeformis* Lesson, L'Echo Monde Sav., 9 (3): 65. Type species by M *Mitra(Harpaeformis)lupulina* Lesson, 1842. Recent.

1965. *Tosapusia* Azuma, Venus: Jap. J. Malac., 24 (1): 55. Type species by OD *Mitropifex isaoi* Kuroda & Sakurai in Kuroda, 1959. Recent.

Shell small to moderate in size, 20 - 80mm, fusiform, often turreted, rather solid; teleoconch of 6 - 12 convex, flat-sided or angulate whorls, protoconch of $1\frac{1}{2}$ - 3 smooth, glassy nuclear whorls. Sculptured with prominent, angulate axial ribs which are widely spaced or even obsolete on the body whorl; spiral striae either confined to the interstices or overriding axial ribs. Aperture narrow, constricted basally, shorter or longer than spire, always lirate within; labial lip generally angulate, thick and simple. Columella calloused, and with 4 - 6 strong, often grooved folds, parietal wall with a callus pad. Siphonal canal short or long, straight or recurved, siphonal fasciole and notch prominent. Periostracum thin and moderately opaque.

The radula (Fig. 121) has bow-shaped rachidians which are equipped with 10 - 22 small, sharp cusps: laterals are simple, sickle-shaped and unicuspid.

Vexillum species live in shallow and deeper water, buried in sand, mud and coral rubble. *Vexillum* are confined to the Indo-Pacific region; they are a fairly recent offshoot of the Indo-Pacific *Costellaria.*

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific.

STRATIGRAPHICAL RANGE: Pliocene — Recent.

CHARACTERISTIC SPECIES:

PLIOCENE — Indonesia: *batavianum* Martin, 1884; *curviliratum* Sowerby, 1874; *pomaliense* Oostingh, 1935. Philippines: *batavianum* Martin, 1884; *subdivisum* Gmelin, 1791.

RECENT — Indo-Pacific: *buriasense* Tomlin, 1920 (= *elegans* Reeve, 1845); *caffrum* Linnaeus, 1758 (= *bifasciata* Swainson, 1822 = *zonalis* Quoy & Gaimard, 1833); *cingulatum* Lamarck, 1811 (= *cinctella* Lamarck, 1822 = *balteata* Bory St. Vincent, 1827); *coccineum* Reeve, 1844 (= *crocea* Sowerby, 1874 = *jucunda* Dunker, 1879 = *permutata* Dautzenberg & Bouge, 1923); *curviliratum* Sowerby, 1874 (= *ornata* A. Adams, 1853 = *jonkeri* Martin, 1884 = *formosensis* Sowerby, 1889 = *minahassae* Schepman, 1907 = *adornata* Tomlin, 1920 = *utravis* Melvill, 1925); *dennisoni* Reeve, 1844; *funereum* Reeve, 1844 (= *callosa* Reeve, 1845); *gruneri* Reeve, 1844 (= *modesta* Pease, 1867); *isaoi* Kuroda & Sakurai in Kuroda, 1959; *lyratum* Lamarck, 1811; *mirabile* A. Adams, 1853 (= *angulosa* Reeve, 1845 = *macfadyeni* Cox, 1930 = *commutata* Dautzenberg & Bouge, 1923); *plicarium* Linnaeus, 1758 (= *lividum* Röding, 1798 = *plicatum* Röding, 1798 = *balteolata* Reeve, 1844 = *pullata* Reeve, 1844 = *umbrosa* Sowerby, 1874 = *berthae* Sowerby, 1879); *regina* Sowerby, 1828 (= *citrina* Gmelin, 1791 = *elegans* Link, 1807 = *compressa* Sowerby, 1874 = *coloscopulus* J. Cate, 1961 = *filiareginae* J. Cate, 1961); *rugosum* Gmelin, 1791 (= *corrugata* Lamarck, 1811 = *brionae* Sowerby, 1889 = *weberi* Bartsch, 1918); *rugosum intermedium* Kiener, 1838 (= *hybrida* Kiener, 1838); *subdivisum* Gmelin, 1791 (= *costellaris* Lamarck, 1811 = *nigrina* Lamarck, 1811); *taeniatum* Lamarck, 1811 (= *gloriosum* Noodt, 1819 = *vittata* Swainson, 1821); *taylorianum* Sowerby, 1874; *vulpecula* Linnaeus, 1758 (= *superbum* Röding, 1798 = ? *variabilis* Link, 1807 = ? *melongena* Lamarck, 1811 = *crispata* Küster, 1840 = *nodosa* Swainson, 1840 = *fulvolirata* Sowerby, 1879 = *pervariabilis* Dautzenberg, 1935 = *rugata* Dautzenberg, 1935 = *simulans* Dautzenberg, 1935 = *sitangkaianum*, J. Cate, 1968); *vulpecula jukesii* A. Adams, 1853 (= *interrupta* A. Adams, 1853 = *superbiens* Melvill, 1895).

SUBGENUS **Costellaria** Swainson, 1840 (of *Vexillum*)

(Plate 8, figs. 10 - 14 and Plate 9, figs. 1 - 10)

Costellaria Swainson, 1840, Treat. Malac., pp. 130, 320. Type species by M *Mitra rigida* Swainson, 1821 = *Mitra semifasciata* Lamarck, 1811. Recent, Indo-Pacific.

1887. *Uromitra* Bellardi, Mem. R. Accad. Sci. Torino, 38: 277. Type species by SD (Harris, 1897) *U.antegressa* Bellardi, 1887. Mio-Pliocene of Europe.

1927. *Balcomitra* Finlay, Trans. N.Z. Inst., 57: 508. Type species by OD *Mitra paucicostata* Tate, 1889 = *Vexillum (Costellaria) lacertosum* Cernohorsky (herein). Miocene of S.E. Australia.

1929. *Arenimitra* Iredale, Mem. Queensland Mus., 9 (3): 286. Type species by OD *A.arenosa* (Lamarck) = *Voluta exasperata* Gmelin, 1791. Recent.

1929. *Pulchritima* Iredale, Mem. Queensland Mus., 9 (3): 286. Type species (art. 67i of ICZN) *Voluta sanguisuga* Linnaeus, 1758. Recent. (nom. subst. pro *Callithea* Swainson, 1840).
= 1840. *Callithea* Swainson, Treat. Malac., pp. 130, 320. Type species by SD (Herrmannsen, 1846) *Mitra sanguisuga* (Linnaeus) = *Voluta sanguisuga* Linnaeus, 1758. Recent. (non *Callithea* Feisthamel, 1835).
= 1895. *Cyllithea* Melvill & Standen, J. Conch., 8: 103 (nom. null.).

1929. *Mitropifex* Iredale, Austral. Zool., 5 (4): 346. Type species by M *M.quasillus* Iredale, 1929 = *Mitra obeliscus* Reeve, 1844. Recent.

Shell small to moderate in size, 3 - 40mm, fusiform elongate or fusiformly ovate. Sculpture more discreet than in *Vexillum*, axial ribs more slender, the shell less heavy and solid. Labial lip convex or angulate, the aperture lirate within, and the columella with 3 - 6 oblique folds; the siphonal canal short or long, siphonal notch distinct. Periostracum thin, translucent or moderately opaque.

The radula (Fig. 129) has a rachidian with generally multicuspid teeth, and denticles number from 7 - 22; laterals are simple, sickle-shaped and unicuspid.

Species of *Costellaria* flourished during Miocene times, and were almost cosmopolitan in distribution. With the cooling of climates, *Costellaria* became extinct in the Mediterranean region, the Western Atlantic, the Eastern Pacific, New Zealand and S.E. Australia. In the temperate waters of South Africa, S.E. Australia and New Zealand, tropical *Costellaria* have been replaced by the closely related *Austromitra* group of species. The small, finely sculptured *Costellaria* species are readily separated from the large, angulate and heavy *Vexillum*, but the proper location of the larger species of *Costellaria* may remain problematical.

Costellaria species are highly variable in characters of sculpture and shape of whorls. The whorls in both *Vexillum* and *Costellaria* may be distinctly convex or angulate in the same species (see *V.exasperatum*, Plate 9, figs. 4 - 5); in juvenile and immature specimens, the whorls are always more convex than in mature adults. The number of axial ribs may reach three times the minimum number

of axial ribs observed in a species; the number of axial ribs counted in a series of individuals of *Vexillum* (*Costellaria*) *acupictum* (Reeve), varied from 16 - 47 on the body whorl. Juvenile shells of *Costellaria* are shorter and broader than adults of the species, and there is a marked decrease in obesity with progressing maturity. The labral lirae are always well developed in mature specimens of *Costellaria* species, but are often unformed in juveniles.

The type species of *Uromitra* Bellardi is generally cited as *Voluta cupressina* Brocchi, 1814, by subsequent designation of Cossmann, 1899 (Palmer, 1937; Gardner, 1937; Harris & Palmer, 1946; Olsson & Harbison, 1953; Coan, 1966—corrected by Woodring, 1964). Harris' prior type designation (1897) of *Uromitra antegressa* Bellardi as the type of *Uromitra,* changes the concept of generic interpretation only slightly, but sufficiently to regard *Uromitra* as a superfluous genus group. The slender, fusiform *cupressina* form is not confined to fossil species of *Costellaria,* but similarly shaped species may be found among tropical *Costellaria* species (e.g. *Vexillum* (*Costellaria*) *radius* Reeve).

GEOGRAPHICAL DISTRIBUTION: Caribbean; Indo-Pacific (Recent).

STRATIGRAPHICAL RANGE: Eocene — Recent.

CHARACTERISTIC SPECIES:

EOCENE — Europe: *terebellum* Lamarck, 1803. United States: *brazosana* Palmer & Brann, 1966 (=*exile* Gabb, 1860); *gracile* Lea, 1841 (= *cincta* Meyer, 1886); *grantense* Johnson, 1899; ? *minori* Hanna, 1927; *terplicatum* de Gregorio, 1890 (= *lineata* Lea, 1833).

OLIGOCENE — S.E. United States: *cellulifera* Conrad, 1848.

MIOCENE — Europe: *antegressum* Bellardi, 1887; *cupressinum* Brocchi, 1814 (= *flexuosa* Sasso, 1827 = *elegans* Michelotti, 1847 = *borsoni* Bellardi, 1850 = *recticosta* Bellardi, 1850 = *michelottii* Hornes, 1856, etc.). Florida: *ambipleura* Gardner, 1937; *barnardense* Maury, 1910 (= *myttonis* Maury, 1910); *cnestum* Gardner, 1937 (= *mangilopse* Gardner, 1937 = *mikkulum* Gardner, 1937); *hosfordense* Mansfield, 1930 (= *climax* Gardner, 1937 = *libertiense* Mansfield, 1930); *myra* Dall, 1915; *scopuli* Maury, 1910; *syra* Dall, 1915; *triptum* Gardner, 1937; *wandoense climacoton* Gardner, 1937 (= *ctenotum* Gardner, 1937 = *hamadryas* Gardner, 1937). Virginia: *wandoense mauryi* Olsson, 1916. Caribbean: *bristoli* Maury, 1925; *cucurrupiense* Oinomikado, 1939; *elachista* Woodring, 1964; *laterculatum voraginosum* Woodring, 1928; *orthocolpum* Cossmann, 1913; *styria callipictum* Woodring, 1928; *syntomum* Woodring, 1928; *tortuosum* Gabb, 1873 (= *tortuosella* Pilsbry & Johnson, 1917 = *frater* Pilsbry & Johnson, 1917); *uncidum* Woodring, 1928. Indonesia: *bayeri* Koperberg, 1931; *deningeri* Martin, 1916; *dijki* Martin, 1906; *druyvesteyni* Koperberg, 1931; *gembacanum* Martin, 1884 (= *ickei* Martin, 1906); *martini* Böttger, 1882; *progoense* Martin, 1916; *tjilonganense* Martin, 1906; *vandervlerki* Koperberg, 1931. Japan: *makiyamai* Shuto, 1962. Okinawa: *amanda gonzabuense* MacNeil, 1960; *obeliscus* Reeve, 1844. Fiji: *radius* Reeve, 1845. S.E. Australia: *biornatum* Tate, 1889; *escharoides* Tate, 1889; *lacertosum* Cernohorsky, 1970 (= *paucicostata* Tate, 1889); *leptaleum* Tate, 1889 (= *euglypha* Tate, 1889). New Zealand: *neozelanicum* Laws, 1939; *etremoides* Finlay, 1924.

PLIOCENE — Europe: *bellardiana* Foresti, 1879; *cupressinum* Brocchi, 1814. Florida: *dalli* Gardner & Aldrich, 1919; *gunteri* Olsson & Harbison, 1953; *healeyi* Fargo, 1948; *wandoense* Holmes, 1860 (= *rushii* Dall, 1887 = *holmesii* Dall, 1890); *wilcoxii* Dall, 1890 (= *coxianum* Fargo, 1951). India: *lirocostatum* Cossmann, 1903. Indonesia: *acuminatum* Gmelin, 1791 (= *rajaensis* Martin, 1895); *amanda* Reeve, 1845; *javanum* Martin, 1880; *limiticum* Oostingh, 1935; *obeliscus* Reeve, 1844. Philippines: *amanda* Reeve, 1845 (= *greyi* Shuto, 1969). Okinawa: *festum* Reeve, 1845; *fulleri* MacNeil, 1960; *obeliscus* Reeve, 1844; *teschi* MacNeil, 1960. Formosa: *obeliscus* Reeve, 1844. Japan: *nakamurai* Makiyama, 1927; *pauciplicata* Yokoyama, 1928. S.E. Australia: *kalimnanense* Cernohorsky, 1970 (= *terebraeformis* Tate, 1889).

RECENT — Caribbean: *hendersoni* Dall, 1927 (= *hendersoni* Rehder, 1943); *laterculatum* Sowerby, 1874 (= *oriflavens* Melvill, 1925 = *olssoni* McGinty, 1955); *styliolum* Dall, 1927; *styria* Dall, 1889; *trophonia* Dall, 1889 (= *epiphanea* Rehder, 1943); *wandoense* Holmes, 1860. Indo-Pacific: *acupictum* Reeve, 1844 (= *autumnalis* Dohrn, 1861); *albotaeniatum* Hervier, 1898; *amanda* Reeve, 1845 (= *immaculata* Melvill & Standen, 1901 = *malcolmensis* Melvill & Standen, 1901 = *marciae* Sowerby, 1913); *angustissimum* E. A. Smith, 1903; *bellum* Pease, 1860; *cadaverosum* Reeve, 1844 (= *mutica* Dautzenberg & Bouge, 1923 = *rubrozonata* Dautzenberg & Bouge, 1923); *caelatum* Reeve, 1845 (= *flexicostata* Garrett, 1880); *caliendrum* Melvill & Standen, 1901; *castum* H. Adams, 1872 (= *hastata* Sowerby, 1874); *chelonia* Reeve, 1845 (= *honesta* Melvill, 1895 = *sculptispira* Sowerby, 1913); *collinsoni* A. Adams, 1864 (= *polycymata* J. Cate, 1963); *cophinum* Gould, 1850 (= *antonellii* Dohrn, 1861); *corbicula* Sowerby, 1870 (= *diamesa* Hervier, 1898); *coronatum* Helbling, 1779 (= *concentrica* Reeve, 1844 = *nodilirata* A. Adams, 1853 = *astephana* Melvill, 1904); *costatum* Gmelin, 1791 (= *subulata* Lamarck, 1811 = *ignea* Wood, 1828 = *terebralis* Broderip, 1836 = *vitellina* Gould, 1850 = *lanceolata* Hervier, 1898 = *isaotakii* Kuroda, 1961); *acuminatum* Gmelin, 1791 (= *elata* Röding, 1798 = *rosea* Kiener, 1838 = *crebrilirata* Reeve, 1844 = *impressa* Reeve, 1844 = *rubricata* Reeve, 1845 = *layardii* A. Adams, 1855 = *tenuilirata* Sowerby, 1874); *cruentatum* Gmelin, 1791 (= *harpiifera* Lamarck, 1811 = *harpaeformis* Lamarck, 1822 = *armillata* Reeve, 1845 = *vibex* (pars) A. Adams, 1853 = *proxima* G. & H. Nevill, 1875 = *sandvichensis* G. & H. Nevill, 1875); *daedalum* Reeve, 1845 (= *rufofilosa* E. A. Smith, 1876 = *helenae* Bartsch, 1915); *deshayesii* Reeve, 1844 (= *fidicula* Gould, 1850 = *dunkeri* Jickeli, 1874 = *alauda* Sowerby, 1874 = *nigricans* Dautzenberg & Bouge, 1923); *diaconalis* Melvill & Standen, 1903; *discolorium* Reeve, 1845 (= *dilectissima* Melvill & Sykes, 1899); *echinatum* A. Adams, 1853 (= *mucronata* Broderip, 1836); *emiliae* Garrett, 1880 (= *plicatula* Pease, 1868 = *micra* Pilsbry, 1908 = *nigritella* Bartsch, 1918); *exasperatum* Gmelin, 1791 (= *torulosa* Lamarck, 1811 = *corrugata* Wood,

1828 = *tunicula* Deshayes in Cuviér, 1838 = *transenna* Melvill, 1888 = *hadfieldi* Melvill & Standen, 1895 = *pasithea* Melvill & Standen, 1901 = *candida* Dautzenberg & Bouge, 1923 = *exusta* Dautzenberg & Bouge, 1923 = *michaelis* Iredale, 1929); *festum* Reeve, 1845 (= *bancalanensis* Bartsch, 1918); *filistriatum* Sowerby, 1874; *fortiplicatum* Pease, 1868 (= *aubryana* Hervier, 1898 = *kewaloensis* J. Cate, 1963); *fuscoapicatum* E. A. Smith, 1879 (= *bronni* Dunker, 1860 = *suluensis* E. A. Smith, 1875 = *gotoensis* E. A. Smith, 1879); *geoffreyana* Melvill, 1910; *granosum* Gmelin, 1791 (= *cancellata* Röding, 1798); *hervieri* Dautzenberg & Bouge, 1923 (= *decipiens* Dautzenberg & Bouge, 1923); *interruptum* Anton, 1839 (= *cimelium* Reeve, 1945 = *nodulosa* Pease, 1868); *interstriatum* Sowerby, 1870 (= *thaanumi* Pilsbry, 1921); *iredalei* Powell, 1958; *iteina* Melvill, 1918; *hirasei* Kira, 1962; *leucozonias* Deshayes in Laborde & Linant, 1834 (= *cineracea* Reeve, 1845 = *judaeorum* Dohrn, 1861 = *moana* J. Cate, 1963); *ligatum* A. Adams, 1853; *macrospirum* A. Adams, 1853 (= *tokubei* Sakurai & Habe, 1964); *mica* Reeve, 1945; *michaui* Crosse & Fischer, 1864 (= *rigida* Reeve, 1844 = *intertaeniata* Sowerby, 1874 = *laevicostata* Sowerby, 1874 = *pulchra* Garrett, 1880); *militaris* Reeve, 1845 (= *coronense* J. Cate, 1968); *modestum* Reeve, 1845 (= *lubens* Reeve, 1845 = *compta* A. Adams, 1853 = *eudianthe* Melvill, 1895 = *farda* J. Cate, 1963); *lucidum* Reeve, 1845 (= *nodulifera* A. Adams, 1853); *mutabile* Reeve, 1845 (= *asperrima* Dohrn, 1862 = *montrouzieri* Souverbie, 1875 = *souverbiei* Dautzenberg & Bouge, 1923); *nitidissimum* Melvill & Standen, 1895 (= *capricornea* Hedley, 1907 = *rubida* Dautzenberg & Bouge, 1923); *nodospiculum* Cernohorsky, 1970; *obeliscus* Reeve, 1844 (= *andamanica* G. & H. Nevill, 1875 = *subtruncata* Sowerby, 1874 = *quasillus* Iredale, 1929); *obtusispinosum* Sowerby, 1874; *pacificum* Reeve, 1845 (= *wisemani* Dohrn, 1860 = *contempta* Dautzenberg & Bouge, 1923 = *rosea* Dautzenberg & Bouge, 1923); *pagodula* Hervier, 1898; *percnodictya* Melvill, 1888; *pharaonis* Issel, 1869 (= *revelata* Melvill, 1899); *politum* Reeve, 1844; *polygonum* Gmelin, 1791 (= *aurata* Röding, 1798 = *angulosa* Küster, 1839 = *marmorea* A. Adams, 1853 = *dohrni* A. Adams, 1864); *radius* Reeve, 1845 (= *longispira* Sowerby, 1874 = *cerithina* Melvill, 1888); *radix* Sowerby, 1874; *roseum* Broderip, 1836 (= *pharaonis* H. Adams, 1872 = *appellii* Jickeli, 1874 = *brevicaudata* Sowerby, 1874); *roseotinctum* Hervier, 1898 (= *diutenera* Hervier, 1898 = *eruda* J. Cate 1963); *rubrocostatum* Habe & Kosuge, 1966; *rusticum* Reeve, 1845 (= *zelotypa* Reeve, 1845 = *subquadrata* Sowerby, 1874 = *crispa* Garrett, 1873); *sanguisugum* Linnaeus, 1758 (= *strigosa* Gmelin, 1791 = *stigmataria* Lamarck, 1811 = *immaculata* Tapparone-Canefri, 1879 = *condoriana* Dautzenberg & Fischer, 1906 = *albida, caerulescens* and *castaneosticta* all Dautzenberg & Bouge, 1923); *scitulum* A. Adams, 1853 (= *interpunctata* Odhner, 1920); *sculptile* Reeve, 1845 (= *delicata* A. Adams, 1864 = *interviewi* Ray, 1954 = *kurodai* Sakurai & Habe, 1964); *semifasciatum* Lamarck, 1811 (= *rigida* Swainson, 1821); *semisculptum* Adams & Reeve, 1850 (= *caloxesta* Melvill, 1888); *spicatum* Reeve, 1845 (= *fusiformis* Kiener, 1838); *stainforthii* Reeve, 1842; *stephanucha* Melvill ,1897; *suluense* Adams & Reeve, 1850 (= *rectilateralis* Sowerby, 1874 = *exquisita* Sowerby, 1889 = *tomlini* Melvill, 1925); *tankervillei* Melvill, 1888 (= *rugosa* Swainson in Sowerby, 1825); *turrigerum* Reeve, 1845 (= *armiger* Reeve, 1845 = *turricula* A. Adams, 1853 = *humilis* Hervier, 1898 = *rufobalteata* Hervier, 1898 = *quaesita* Melvill, 1925); *unifasciatum* Wood, 1828 (= *clathrata* Reeve, 1844 = *decora* Reeve, 1844 = *propinqua* Garrett, 1880 = *dorotheae* Melvill & Standen, 1896); *verecundulum* Hervier, 1898; *virginalis* Lesson, 1842 (= *pallida* A. Adams, 1853); *zebuense* Reeve, 1844 (= *rorata* Gould, 1850 = *rubella* Adams & Reeve, 1850 = *rufomaculata* Souverbie, 1860 = *salmonea* Sowerby, 1874 = *praetexta* Sowerby, 1874 = *puncturata* Sowerby, 1878 = *chariessa* Melvill, 1888).

SUBGENUS Pusia Swainson, 1840 (of *Vexillum*)

(Plate 9, figs. 11 - 20 and Plate 10, figs. 1 - 4)

Pusia Swainson, 1840, Treat. Malac., p. 320. Type species by M *P.microzonis* (Lamarck) = *Mitra microzonias* Lamarck, 1811. Recent, Indo-Pacific.

= 1903. *Pasia* Martens, Wiss. Ergeb. Valdivia, 7: 53 (nom. null.).

= 1911. *Pussia* Friedberg, Moll. Mioc. Polon. Reg., p. 19 (nom. null.).

1917. *Ebenomitra* Monterosato, Boll. Soc. Zool. Ital., 4: 26. Type species by SD (Coan, 1966) *Mitra ebenus* Lamarck, 1811. Recent.

1921. *Pusiolina* Cossmann, Rev. Crit. Paleozool., 25 (2): 79. Type species (art. 67i of ICZN) *Voluta tricolor* Gmelin, 1791. Recent. (nom. subst. pro *Pusiola* Monterosato, 1917).

= 1917. *Pusiola* Monterosato, Boll. Soc. Zool. Ital., 4: 26. Type species by M *P.tricolor* Gmelin = *Voluta tricolor* Gmelin, 1791. Recent. (non *Pusiola* Wallengren, 1863).

1921. *Idiochila* Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, 72: 311. Type species by OD *Vexillum turben* (Reeve) = *Mitra turben* Reeve, 1844. Recent.

Shell very small to moderately small, 5 - 30mm, elongate ovate or ovate, acuminate at ends, generally solid; teleoconch of 5 - 10 convex or flat-sided whorls, protoconch of 1½ - 3 smooth nuclear whorls. Sculptured with axial ribs and spiral striae or cords, occasionally with nodes on the presutural ramp. Aperture shorter or longer than spire, moderately wide or narrow, always lirate within; labial lip thickened or thin, simple. Columella calloused and with 3 - 5 prominent, oblique folds, parietal wall with a callus pad. Siphonal canal straight or slightly recurved, short or moderately produced. Periostracum thin.

The radula of the type species of *Pusia* is unknown, but the radula of other similar species of the group is either multicuspid Vexilline or tricuspid Pusiine. The appearance of either type in *Pusia* species is erratic, and has no connection with changes of shell structure or habitat. The somewhat similar species *V.(P.) luculentum* (Reeve) and *V.(P.) cavea* (Reeve), have a Vexilline and Pusiine radula respectively; both species are coral reef dwellers, and are found in similar habitats.

Pusia is closely related to *Costellaria*, but in contrast to *Costellaria* species which live buried in mud and sand, *Pusia* species inhabit cracks and crevices of coral reefs and the underside of stones. All the *Pusia* species collected by the writer were found under coral blocks and in crevices of reef platforms, or dredged on a coral rubble substratum. It is assumed that species of the *Pusia* group are actually *Costellaria* species which have abandoned their sand and mud habitat for a coral reef and solid substrate environment, and adopted a more compact, ovate and solid shape more suitable for survival on reefs swept by heavy surf.

GEOGRAPHICAL DISTRIBUTION: Mediterranean; East Atlantic; Caribbean; Indo-Pacific; S.E. Australia (Recent).

STRATIGRAPHICAL RANGE: Eocene — Recent.

CHARACTERISTIC SPECIES:

EOCENE — Europe: *inchoata* Cossmann & Pissarro, 1901; *intortellum* Cossmann, 1896. England: *volutiforme* Edwards, 1856 (Fig. 181).

OLIGOCENE — Indonesia: *bicatenatum* Martin, 1935.

MIOCENE — Europe: *avellanella* Boettger, 1906; *bicoronatum* Seguenza, 1880 (= *bicoronata* Bellardi, 1888); *ebenus pyramidellum* Brocchi, 1814 (= *plicatula* Brocchi, 1814, etc.); *funalis* Bellardi, 1888; *januszkiewiszi* Friedberg, 1928; *paraleucozonum* Boettger, 1906; *textiliosum* Bellardi, 1888; *transsylvanicum* Zilch, 1934. Caribbean: *bullen-newtoni* Maury, 1917; *dasaplurum* Woodring, 1928; *leurum* Woodring, 1928; *micramaidum* Woodring, 1928 (= *cryptidulum* Woodring, 1928); *scopuli* Maury, 1910. Indonesia: *ardjunoi* Beets, 1941 (= *escheri* Beets, 1941); *cheribonense* Martin, 1896; *menkravitense* Beets, 1941.

PLIOCENE — Europe & England: *ebenus* Lamarck, 1811. Indonesia: *cheribonense* Martin, 1896. Japan & Okinawa: *emmae* Yokoyama, 1920; *tuberosum* Reeve, 1845. Fiji: *microzonias* Lamarck, 1811.

RECENT — Europe & E. Atlantic: *ebenus* Lamarck, 1811; *tricolor* Gmelin, 1791; *zebrina* d'Orbigny, 1839 (= *semen* Reeve, 1845 = *capillata* Gould, 1850); *sanctaehelenae* E. A. Smith, 1890. Caribbean: *dermestina* Lamarck, 1811 (= *albicostata* C. B. Adams, 1850); *epiphanea* Rehder, 1943; *exiguum* C. B. Adams, 1845 (= *hanleyi* Dohrn, 1862 = *gemmata* Sowerby, 1874 = *roseocaudata* Sowerby, 1874 = *sykesi* Melvill, 1925 = *moisei* McGinty, 1955 = *hayesae* Nowell-Usticke, 1959); *histrio* Reeve, 1844 (= *articulata* Reeve, 1845 = *albocincta* C. B. Adams, 1845 = *bifasciata* Mörch, 1852 = *cruzana* Nowell-Usticke, 1959); *puella* Reeve, 1845 (= *albomaculata* Sowerby, 1874); *pulchellum* Reeve, 1844. S.E. Australia: *australe* Swainson, 1820 (= *melaleuca* Quoy & Gaimard, 1833 = *kieneri* Sowerby, 1874 = *vincentiana* Verco, 1896). Indo-Pacific: *accinctum* Sowerby, 1907; *alveolus* Reeve, 1845; *amabile* Reeve, 1845 (= *encausta* Gould, 1850); *approximatum* Pease, 1860 (= *dimidiata* Sowerby, 1870 = *xenium* Pilsbry, 1921); *bernhardina* Röding, 1798 (= *muriculata* Lamarck, 1811 = *stefaninii* Nardini, 1934); *blanfordi* Melvill & Standen, 1901; *cancellarioides* Anton, 1839 (= *fraga* Kiener, 1838 = *tuberculata* Kiener, 1839 = *pinguis* Reeve, 1845 = *nodosa* auctt.); *catenatum* Broderip, 1836 (= *nasuta* Sowerby, 1874 = *zythochroa* Melvill, 1888 = *smithi* Sowerby, 1890 = *recurva* Sowerby, 1890 = *recurvirostris* Sowerby, 1908 = *pluricostata* Dautzenberg & Bouge, 1923); *cavea* Reeve, 1844 (= *porphyretica* Reeve, 1844 = *satsumae* Dall, 1926); *cithara* Reeve, 1845 (= *arracanensis* Sowerby, 1874 = *georgii* Melvill & Sykes, 1899); *consanguineum* Reeve, 1845 (= *russa* Gould, 1860); *corallina* Reeve, 1845 (= *xerampelina* Melvill, 1895); *crocatum* Lamarck, 1811 (= *aurantia* Broderip, 1836 = *concinna* Reeve, 1844 = *cumingii* Reeve, 1844 = *flavescens* Reeve, 1844 = *pyramidalis* Reeve, 1844 = *imitatrix* Dautzenberg & Bouge, 1923); *depexum* Deshayes in Laborde & Linant, 1834 (= *shop-landi* Melvill, 1895); *ficulina* Lamarck, 1811 (= *forticostata* Reeve, 1845); *inermis* Reeve, 1845 (= *aemula* E. A Smith, 1879 = *vanattai* Pilsbry, 1901 = *hizenensis* Pilsbry, 1921); *infaustum* Reeve, 1845 (= *fulvosulcata* Melvill, 1888 = *elizae* Melvill, 1899); *kraussi* Dunker, 1861 (= *nakama* Dall, 1926); *lautum* Reeve, 1845 (= *adamsi* Dohrn, 1862); *leucodesmum* Reeve, 1845; *lotum* Reeve, 1845; *luculentum* Reeve, 1845 (= *dichroa* Adams & Reeve, 1850 = *tricolor* Montrouzier, 1861 = *graeffei* Crosse, 1867 = *laevizonata* Sowerby, 1874 = *nigrofas-ciata* Sowerby, 1874 = *albida* Dautzenberg & Bouge, 1923 = *nigra* Dautzenberg & Bouge, 1923); *mediomaculatum* Sowerby, 1870; *microzonias* Lamarck, 1811 (= *sulcata* Gmelin, 1791 = *semiplicata* Broderip, 1836 = *discors* Küster, 1840 = *bilineata* Reeve, 1845 = *infrafasciata* Souverbie, 1865 = *glabra* Pease, 1868 = *lubrica* Pease, 1869 = *vavakuana* Ladd & Hoffmeister, 1945); *millecostatum* Broderip, 1836 (= *antonii* Küster, 1839 = *adam-soni* Reeve, 1844 = *crocea* Reeve, 1845 = *evelynae* Melvill, 1895); *morlleri* Küster, 1840 (= *flammulata* Pease, 1868 = *zebrina* Garrett, 1873 = *baldwinii* Melvill, 1899); *oniscina* Lamarck, 1811 (= *glandiformis* Reeve, 1845 = *bipartita* E. A. Smith, 1884); *osiridis* Issel, 1869 (= *umbonata* Sowerby, 1870); *pardalis* Küster, 1840; *patriar-chalis* Gmelin, 1791 (= *depressa* J. Cate, 1963); *patulum* Reeve, 1845 (= *simplex* Dunker, 1846 = *merula*

Fig. 181. *Vexillum*(*Pusia*)*volutiforme* (Edwards, 1856). Barton beds, U. Eocene of England; length 6.3mm (from Edwards, 1856, pl. 24, fig. 5).

Sowerby, 1889 = *fidis* Sowerby, 1916 = *lurida* Turton, 1932); *piceum* Pease, 1860 (= *putillus* Pease, 1865 = *lipara* J. Cate, 1963); *pisolinum* Lamarck, 1811 (= *cremans* Reeve, 1845); *purpuratum* Reeve, 1845; *rubrum* Broderip, 1836 (= *rhodinosphaera* Melvill, 1888 = *rhodochroa* Hervier, 1898 = *pilsbryi* Hedley, 1899); *semicostatum* Anton, 1839; *speciosum* Reeve, 1844 (= *trizonalis* Dautzenberg, 1935); *suavis* Souverbie, 1875 (= *goubini* Hervier, 1898 = *plurinotata* Hervier, 1898 = *mitata* J. Cate, 1963); *tuberosum* Reeve, 1845 = *meganodosa* MacNeil, 1960); *turben* Reeve, 1844 (= *kanaka* Pilsbry, 1921); *tusum* Reeve, 1845 (= *olgae* J. Cate, 1963 = *propetusa* J. Cate, 1963 = *stearnsiana* J. Cate, 1963); *unifascialis* Lamarck, 1811 (= *multicostata* Broderip, 1836 = *aureolata* Reeve, 1844 = *speciosa* Reeve, 1844 = *venustula* Reeve, 1844 = *affinis* Reeve, 1845 = *variata* Reeve, 1845 = *fratercula* Garrett, 1873 = *paligera* Sowerby, 1874 = *semitica* Jickeli, 1874 = *bizonalis* Dautzenberg & Bouge, 1923).

Genus **Austromitra** Finlay, 1927

(Plate 10, figs. 5 - 11)

Austromitra Finlay, 1927, Trans. N.Z. Inst., 57: 410. Type species by OD *Columbella rubiginosa* Hutton, 1873. Recent, New Zealand.

Shell small, 5 - 20mm, fusiformly elongate to fusiformly ovate; teleoconch of 5 - 6 convex or subangulate whorls, protoconch of $1\frac{1}{2}$ - $2\frac{1}{2}$ smooth, obtuse and slightly mamillate nuclear whorls. Sculptured with axial ribs and spiral striae, axial ribs occasionally obsolete on the last 1 - 2 whorls, or nodulose on the presutural ramp. Aperture narrow, longer or shorter than spire, smooth or lirate within; labial lip convex, slightly constricted anteriorly, thin and simple. Columella with 3 - 4 oblique folds, first posterior fold rather distant from the second fold; parietal wall only weakly calloused, lacking the prominent callus pad of *Vexillum*. Siphonal canal straight or slightly recurved, moderately short, siphonal notch shallow. Periostracum thin.

The radula (Fig. 149) is typically Vexilline; rachidians are equipped with 10 - 13 cusps, laterals are simple, sickle-shaped and unicuspid. The buccal mass is very small, the odontophore extracted from a 11.0mm-long specimen measured 0.37mm in length; the ribbon contained 36 rows of teeth. Species of *Austromitra* inhabit shallow or deeper water; they are found under rocks on a sand substratum, and have been dredged to a depth of 458 metres (250 fathoms).

Ludbrook (1958) remarked on the close relationship of the Austral-Neozelanic *Austromitra* with the South African species previously placed in *Vexillum*. Until fairly recent times, the distribution of *Austromitra* was circumpolar, but after the disappearance of *Austromitra* from Patagonia during the Pliocene, Recent species are confined to the S.E. Atlantic, South Africa and the Austral-Neozelanic region.

Austromitra species show an extraordinary variation in both colour and sculpture; future population studies, particularly those of Australian *Austromitra* species, will undoubtedly contribute towards a reduction in the number of currently accepted species. Species of *Austromitra* have drab-looking, lustreless, unicoloured or banded shells with a less conical and more papillose protoconch of fewer nuclear whorls; the prominent parietal callus pad of *Vexillum* has been replaced by a thin parietal wall glazing.

Geographical distribution: Southern hemisphere. Australia; New Zealand; South Africa; St. Helena (Recent).

Stratigraphical range: Miocene — Recent.

Characteristic species:

MIOCENE — S.E. Australia: *sordida* Tate, 1889 (= *semilaevis* Tate, 1889 = *tatei* Cossmann, 1899 = *ralphi* Cossmann, 1900). New Zealand: *ambulacra* Marwick, 1926; *marwicki* Vella, 1954.

MIO-PLIOCENE — Argentina (Patagonia): *patagonica* Ihering, 1907.

PLIOCENE — S.E. Australia: *angusticostata* Ludbrook, 1941; *mawsoni* Ludbrook, 1958; *multiplicata* Ludbrook, 1958; *pauciplicata* Ludbrook, 1958; *sordida* Tate, 1889. New Zealand: *caudata* Marwick, 1931; *rubiginosa* Hutton, 1873; *quenelli* Fleming, 1943.

RECENT — St. Helena: *innotabilis* E. A. Smith, 1890. South Africa: *bathyraphe* Sowerby, 1900 (= *canaliculata* Sowerby, 1900 = *kowieensis* Sowerby, 1901 = *distincta* Thiele, 1925 = *didyma* Turton, 1932 = *helena* Turton, 1932 = *eucosmia* Turton, 1932 = *becki* Turton, 1933); *capensis* Reeve, 1845 (= *euzonata* Sowerby, 1900 = *ima* Bartsch, 1915 = *albanyana* Turton, 1932 = *hera* Turton, 1932). Australia: *acromialis* Hedley, 1915; *analogica* Reeve, 1845 (= *cinnamomea* A. Adams, 1855 = *vincta* A. Adams, 1855 = *schomburgki* Angas, 1878 = *tatei* Angas, 1879); (the following species may be only colour and sculptural variants of *A.analogica* Reeve: *legrandi* Tenison-Woods, 1876; *scalariformis* Tenison-Woods, 1876; *scita* Tenison-Woods, 1876; *tasmanica* Tenison-Woods, 1876;

teresiae Tenison-Woods, 1876; *weldii* Tenison-Woods, 1878; *bellapicta* Verco, 1909; *volucra* Hedley, 1915; *pumilio* May, 1916); *apicitincta* Verco, 1896; *arnoldi* Verco, 1909; *bucklandi* Gabriel, 1962 (= *bassiana* Gabriel, 1962); *cericostata* Laseron, 1951; *lincolnensis* Angas, 1878; *pellucida* Tate, 1887 (= *jaffaensis* Cotton & Godfrey, 1932); *retrocurvata* Verco, 1909. New Zealand: *rubiginosa* Hutton, 1873 (= *planata* Hutton, 1885 = *angulata* Suter, 1908 = *pseudomarginata* Suter, 1913 = *antipodum* Brookes, 1926 = *rubiradix* Finlay, 1927 = *planatella* Finlay, 1930 = *brunneacincta* Powell, 1952); *erecta* Powell, 1934; *lawsi* Finlay, 1930; *zafra* Powell, 1952. [*Balcomitra macra* Finlay, 1927 (= *exilis* Tate, 1889), from the lower beds at Muddy Creek, Miocene of Victoria, Australia, is a questionable *Austromitra*; no specimens of this species were examined.]

Genus Thala H. & A. Adams, 1853

(Plate 11, figs. 1 - 8)

Thala H. & A. Adams, 1853, Gen. Rec. Moll., 1: 178. Type species by SD (Cossmann, 1899) *Mitra mirifica* Reeve, 1845. Recent, Indo-Pacific.

1888. *Micromitra* Bellardi, Mem. R. Accad. Sci. Torino, 38: 147. Type species by SD (Coan, 1966) *M.taurina* Bellardi, 1888 = *Voluta obsoleta* Brocchi, 1814. Mio-Pliocene of Italy. (non *Micromitra* Meek, 1873).

1958. *Mitromica* Berry, Leafl. Malac., 1 (16): 94. Type species by OD *Mitra solitaria* C. B. Adams, 1852 = *Mitra gratiosa* Reeve, 1845. Recent, Galápagos Islds. - West coast S.W. United States.

Shell small, 5 - 20mm, slender and fusiform to cylindrically fusiform; teleoconch of 6 - 11 convex or subangulate whorls, protoconch of 1 - 2 glassy nuclear whorls, embryonic whorl occasionally nipple-like and inturned. Sculptured with bisecting axial and spiral threads, threads occasionally nodulose producing a beaded or clathrate effect. Aperture very narrow, longer or shorter than spire, lirate within; labial lip thickened and dentate, angulate, constricted basally. Columella with 4 - 7 oblique folds, parietal wall glazed; siphonal canal short or long, straight or recurved, siphonal notch distinct or shallow. Periostracum thin.

The radula (Figs. 151 - 153, 156) is variable, and may be either Pusiine or Vexilline, rachidians have either 3, 5 or 7 cusps, and laterals are simple, sickle-shaped and unicuspid. The animal is equipped with a poison gland, and has been observed killing another mollusc with the extendable poison gland. Species inhabit shallow and deeper water; in the intertidal zone, *Thala* species are found under coral blocks or among marine algae on a hard substratum.

Thala species made their appearance during early Miocene times, and the earliest records are from the European region. *Thala* still survives on both sides of the Panama isthmus and in the Indo-Pacific region. The genus contains a very few species only.

Juvenile shells of *Thala* closely resemble *Costellaria*; the shell is rather ovate, the labial lip is thin and less angulate and labial denticles are still weak or unformed and the aperture becomes narrow and constricted with maturity.

Geographical distribution: Caribbean; Eastern Pacific; Indo-Pacific; ? Eastern Atlantic (Recent).

Stratigraphical range: Miocene — Recent.

Characteristic species:

MIOCENE — Europe: *burdigalensis* Peyrot, 1928; *lapugyensis* Hoernes & Auinger, 1880; *laubei* Hoernes & Auinger, 1880; *minutissima* Degrange-Touzin, 1894 (= *angustissima* Peyrot, 1928); *obsoleta* Brocchi, 1814 (= *partschi* Hörnes, 1856 = *abbreviata* Bellardi, 1888 = *taurina* Bellardi, 1888 = *elatocostata* Sacco, 1904, etc.); *pupa* Dujardin, 1837.

PLIOCENE — Europe: *obsoleta* Brocchi, 1814.

RECENT — Caribbean: *foveata* Sowerby, 1874 (= *floridana* Dall, 1884). Eastern Pacific: *gratiosa* Reeve, 1845 (= *solitaria* C. B. Adams, 1852 = *nodocancellata* Stearns, 1890); *jeancateae* Sphon, 1969. Indo-Pacific: *exilis* Reeve, 1845 (= *jaculanda* Gould, 1860 = *adumbrata* Souverbie, 1876 = *ogasawarana* Pilsbry, 1904 = *ceylanica* Preston, 1904 = *illecebra* Melvill, 1927); *mirifica* Reeve, 1845 (= *recurva* Reeve, 1845 = *roseata* A. Adams, 1855 = *angiostoma* Pease, 1868 = *exquisita* Garrett, 1873 = *angustata* Sowerby, 1874 = *cernica* Sowerby, 1874 = *fusus* Souverbie, 1876 = *puncticulata* Souverbie, 1876); *todilla* Mighels, 1845 (= *milium* Reeve, 1845 = *secalina* Gould, 1860 = *brevicula* Souverbie, 1876 = *simulans* Martens, 1880 = *decaryi* Dautzenberg, 1932).

Genus Zierliana Gray, 1847

(Plate 10, figs. 12 - 16)

Zierliana Gray, 1847, Proc. Zool. Soc. Lond., 17 (178): 141. Type species by OD *Voluta ziervogelii* Gmelin, 1791 (emend. ex *V.ziervoyelii* by Dillwyn, 1817). Recent, Indo-Pacific.

= 1865. *Zerliana* Deshayes, Descr. anim. s. vert. Bass. Paris, 3: 576 (nom. null.).

= 1880. *Zierlina* Garrett, J. Conch., 3: 73 (nom. null.).

= 1884. *Ziervogelia* Fischer, Man. Conchyl., pt. 7: 613 (nom. van.).

= 1899. *Ziervoglia* Cossmann, Ess. paléoc. comp., 3: 151 (nom. null.).
= 1943. *Ziervogeliana* Wenz, Handb. Paläozool., 6 (1): 1289 (nom. van.).

Shell moderately small, 15 - 30mm, elongate ovate or ovate, solid and heavy, sometimes inflated; teleoconch of 5 - 9 convex or flat-sided whorls, protoconch of 1½ glassy nuclear whorls. Sculptured with axial ribs and spiral striae and oblique cords at base; axial ribs with a tendency to become obsolete on the last 2 - 3 whorls, and some individuals are completely smooth. Aperture narrow or moderately wide, longer than spire, lirate within; labial lip thickened, convex, smooth or dentate. Columella with 4 - 5 prominent oblique folds, first posterior fold very large; the parietal wall with a heavy callus pad and forming a distinct anal canal. Siphonal canal short and straight, siphonal notch distinct or shallow. Periostracum thin, and moderately opaque.

The radula (Figs. 154 - 155) is typically Vexilline; the rachidians have 13 - 17 cusps and laterals are simple, sickle-shaped and unicuspid. Species of *Zierliana* live under rocks and coral boulders near the high tide mark; there is no record of a *Zierliana* species having been dredged in deep water.

The sculpture is variable in *Zierliana* species, ribbed and smooth forms occurring in the same species. As in other groups of Mitridae, the broad and slender forms of *Zierliana* species have been specifically separated. In some species, the prominent internal lirations do not reach the edge of the labial lip, and in the species *Z.oleacea* (Reeve), the internal lirae are occasionally covered by a layer of enamel.

The species *Marginella simplicissima* Martin, 1880, from Miocene deposits of Java, is in fact the earliest *Zierliana* on record. There is nothing marginellid about the species, and the heavy callus pad, numerous labial denticles and the 4 mitrid columellar folds associate this species with *Zierliana*. *Zierliana* is a small vexilline group containing only 4 Recent and 1 fossil species.

GEOGRAPHICAL DISTRIBUTION: Indo-Pacific.

STRATIGRAPHICAL RANGE: Miocene — Recent.

CHARACTERISTIC SPECIES:

MIOCENE — Indonesia: *simplicissima* Martin, 1880.

RECENT — Indo-Pacific: *anthracina* Reeve, 1844; *oleacea* Reeve, 1844 (= *nigra* Quoy & Gaimard, 1833 = *quoyi* Deshayes & M. Edwards, 1844); *woldemarii* Kiener, 1838 (= *solidula* Reeve, 1844 — slender, smooth form; = *robusta* Reeve, 1844—broad, plicate form; = *choava* Reeve, 1844—broad, smooth form; = *aethiops* Reeve, 1845 —typical form; = *creniplicata* A. Adams, 1853—slender, plicate form); *ziervogelii* Gmelin, 1791 (= *strombiforme* Burrows, 1815 = *ziervogeliana* Lamarck, 1822).

GENERA OF DOUBTFUL STATUS

Butonina Beets, 1943

(Plate 11, fig. 10)

Butonina Beets, 1943, Leidsche geol. Meded., 13: 290. Type species by OD *B.nudata* Beets, 1943. Buton Island, Upper Oligocene of Indonesia.

This Oligocene genus has been based on an incomplete, badly preserved specimen. Beets (1943) described the species as slender and fusiform, smooth apart from spiral striae and indication of a nodulose axial sculpture. Whorls are flat-sided, sutures weakly impressed, columella with 3 thin and distant folds; aperture is shorter than the spire, labrum presumably smooth, labial lip thin and simple. Siphonal canal is slender, slightly produced and spout-shaped. Length 34.0mm.

The bad preservation of this specimen does not allow a firm placement of the genus in the Mitridae. Beets (loc. cit.) compared his new genus with *c.* 12 mitrid genera, and also considered the turrid genus *Mitrolumna* and the volutomitrid genus *Conomitra* in his comparison. The type species shows some features of an immature *Dentimitra*, the thin and wide-spaced columellar folds and spout-shaped canal would favour the Volutomitridae. The genus is known only by the type species.

Pyrenomitra Eames, 1952

(Plate 11, fig. 9)

Pyrenomitra Eames, 1952, Phil. Trans. Roy. Soc. Lond., 236: 105. Type species by OD *P.anachis* Eames, 1952. Rakhi Nala, Upper Eocene of W. Pakistan.

The types of *Pyrenomitra anachis* are very small, juvenile and imperfectly preserved specimens. The species was described as ovate-conic to subfusiform, with a subtectiform protoconch consisting of

4 smooth whorls of relatively large size. Sculpture consists of a beaded circumsutural spiral collar and a spiral thread anteriorly to it, basal spiral cords and axial ribs. The columella has 4 weakly developed folds, and the labrum was presumably lirate according to the author, although there is no evidence to substantiate this assumption. Length 3.1mm, width 1.9mm.

The unusually high number of nuclear whorls in relation to the fully formed postnuclear whorls, suggest that the specimens are juveniles of a *Conomitra*.

Egestas Finlay, 1927

(Plate 12, figs. 1 - 3)

Egestas Finlay, 1927, Trans. N.Z. Inst., 57: 411. Type species by OD *Vexillum waitei* Suter, 1909. Recent, New Zealand.

Shell small, 5 - 10mm, fusiformly elongate, teleoconch of 4 - 5 angulate whorls, protoconch of 1½ smooth nuclear whorls. Sculptured with coarse and broad axial folds and close set, prominent spiral cords; sutures with an impressed spiral thread. Aperture moderately wide or narrow, shorter than the spire, smooth within, labial lip thin and simple. Columella slightly calloused, and with 3 very small and moderately short folds; the siphonal canal with a tendency to cut away to the left, and siphonal notch absent. Well-preserved specimens uniformly brown in colour.

In sculpture, form and features of canal, *Egestas waitei* looks more like the fasciolarid genus *Latirus*. The protoconch (Fig. 182), unnotched base and disposition of columellar folds bear no similarity to any known mitrid species. *Egestas waitei* is a deep-water species, and dead specimens are frequently dredged at depth ranging from 90 - 140 metres (50 - 75 fathoms).

The Awamoan *Egestas fenestrata* (Suter, 1917) from Pukeuri, Lower Miocene of New Zealand, is also assignable to this genus. The recent species *Egestas dissimilis* Powell, is a synonym of *Peculator hedleyi* (Murdoch) in the family Volutomitridae. *Egestas* is a noun of feminine gender and paleontological faunal lists should be emended accordingly.

Fig. 182. *Egestas waitei* (Suter, 1909). Recent, New Zealand. Protoconch.

GENERA NOT REFERABLE TO THE MITRIDAE

Pleioptygma Conrad, 1863

(Plate 11, fig. 11)

Pleioptygma Conrad, 1863, Proc. Acad. Nat. Sci. Philadelphia, 14: 563. Type species by M *Voluta carolinensis* Conrad, 1840. Miocene of Nth. Carolina.

= 1899. *Plioptygma* Cossmann, Ess. paléoc. comp., 3: 150 (nom. null.).

Shell large, up to 120mm, fusiform, elongate, inflated and light in weight; teleoconch of 6-8 slightly convex whorls, protoconch of 2 - 2½ smooth nuclear whorls. Sculptured with deep spiral grooves or cords on early whorls and irregularly spaced spirals on the body whorl; spiral grooves may become obsolete on the centre of the body whorl, and interstices of spiral cords are minutely axially striate. Aperture elongate, slightly longer than the spire, smooth within, labial lip thin and simple; columella with numerous, up to 9 in type species, irregular and thin folds, first 1 - 2 posterior folds thinner and weaker. Siphonal notch absent, columella with a large and thin callosity extending from aperture to base.

GEOGRAPHICAL AND STRATIGRAPHICAL DISTRIBUTION: Miocene of Carolina (? and Egypt); Pliocene of Florida.

There is no similar species of Tertiary or Recent Mitridae which even superficially resembles *Pleioptygma*. Features of large size, inflated and light shell, large columellar callus, absence of a siphonal notch and thin, irregular, often intercalate columellar folds, are all consistent with the Volutidae. An assignment to the subfamily Scaphellinae might be appropriate.

Neoimbricaria v. Ihering, 1907

(Plate 11, fig. 13)

Neoimbricaria v. Ihering, 1907, Ann. Mus. Nac. Buenos Aires, 7: 196, 198. Type species by SD (Cossmann, 1909) *Voluta patagonica* v. Ihering, 1897. Miocene of Patagonia, Sth. America.

Shell moderately small, *c.* 30mm, fusiform and inflated, whorls convex, slightly angulate on presutural ramp, protoconch small but papillate. Sculptured with elegant axial ribs and fine spiral striae. Aperture longer than the spire, smooth within, labial lip reflected; columella calloused, and with 4 - 5 volutid-like folds, third anterior fold most prominent.

Ihering (1907) included in his new genus several Tertiary Patagonian Marginellidae, besides *Voluta patagonica*. He remarked that in features of apex, general form and apertural features, *V.patagonica* belongs in the Volutidae. Cossmann (1899) included *V.patagonica* in the volutid genus *Vespertilio*. Wenz (1943) and Coan (1966), referred *Neoimbricaria* to the Mitridae, without an explanation as to the reason for such a re-assignment. The Tertiary *Neoimbricaria* closely resembles the Oligocene-Recent New Zealand species of *Pachymelon* Marwick, and *Neoimbricaria* would be more appropriately placed in the subfamily Alcithoinae, family Volutidae.

Clifdenia Laws, 1932

(Plate 11, fig. 12)

Clifdenia Laws, 1932, Trans. N.Z. Inst., 62 (3/4): 196. Type species by OD *C.turneri* Laws, 1932. Mid-Miocene of New Zealand.

Shell large, up to 152mm, fusiform, teleoconch of 10 convex whorls, protoconch unknown. Early whorls with slender axial ribs which become obsolete on later whorls; on the body whorl, the axial growth striae close set and only slightly arcuate. Spiral sculpture consisting of 5 - 6 spiral threads confined to the sutures. Aperture narrow and elongate, longer than the spire, smooth within; labial lip thickened and calloused on edge, smooth, perpendicular and constricting toward anterior third. Columella prominently calloused, callus extending in a crescent shape on to the body whorl; the 4 - 6 columellar folds deeply recessed and distant, the second posterior fold slightly thicker than remainder; lower part of columella humped and knobbly.

GEOGRAPHICAL AND STRATIGRAPHICAL DISTRIBUTION: *Clifdenia* sp. Duntroonian, Lower Oligocene of N.Z.; *C.turneri inflata* Grant-Mackie, 1965, Otaian, Lower Miocene of N.Z.; *C.turneri turneri* Laws, 1932, Altonian and Lillburnian, Mid-Miocene of N.Z.

The author described the species as a "volute-like member of the Mitridae", with an outer lip which has a tendency to reflection and spreads widely in a volute-like callus, an aperture which comes vertically down as in *Spinomelon,* and growth striae which sweep laterally across the fasciole much as in *Alcithoe*. The author acknowledged the species to be "distinctive in its peculiarly volutid appearance", but assigned the species to the Mitridae on the basis of "decrease in size of the pillar plaits". The columellar plaits in *C.turneri* are very unmitrid-like; they are distant, with interspaces twice the width of the thickness of the folds, they are far too deeply recessed for any mitrid, and the folds do not decrease in size from top to bottom; the second posterior fold is slightly thicker than the first. This character seems to be of little significance in the Volutidae, and in the genera *Amoria* and *Scaphella,* the first posterior fold is often the largest, and in other volutids, the folds may be of equal size.

Wenz (1943), Grant-Mackie (1965), Fleming (1966) and Coan (1966), all retained *Clifdenia* in the Mitridae. The relationship of *Clifdenia* is with the Scaphellinae. in the family Volutidae.

Lapparia Conrad, 1855

(Plate 11, fig. 14)

Lapparia Conrad, 1855, Proc. Acad. Nat. Sci. Philadelphia, 7: 260. Type species by M *Mitra*(*Lapparia*)*dumosa* Conrad = *Mitra dumosa* Conrad in Wailes, 1854. Eocene of Mississippi, S.E. United States.

Lapparia was originally described in the Mitridae, and was retained in that family by Stenzel & Turner (1940). Wenz (1943) assigned *Lapparia* to the Volutidae, and Pilsbry & Olsson (1954) placed *Lapparia* in the volutid subfamily Volutilithinae. The smooth species of *Lapparia*, i.e. *L.pactilis* (Conrad), bear a close resemblance to *Mitreola* Swainson.

Mitreola Swainson, 1833

(Plate 12, figs. 4 - 5)

Mitreola Swainson, 1833, Zool. Illust., ser. 2, 3: pl. 128. Type species by SD (Herrmannsen, 1847) *Mitra monodonta* (Lamck. ?) Swainson = *Mitra monodonta* Lamarck, 1803. Eocene of Paris Basin, France.

Species of the Eocene genus *Mitreola* are superficially similar to the mitrid group *Strigatella*. The nuclear whorls are, however, mamillate and nipple-like, the columella has a volutid callus and the arrangement of the columellar folds is more volutid than mitrid; the first posterior fold is shorter than the second fold, and the labial lip has an interior callus or denticle.

Coan (1966) retained *Mitreola* in the Mitridae, and the writer (1966d) assigned *Mitreola* to the Mitridae with a query. Pilsbry & Olsson (1954) removed *Mitreola* to the subfamily Lyriinae in the Volutidae; this placement seems to be quite appropriate. *Mitreola* species flourished in Europe during Eocene times and also lived during the Miocene in the Tertiary Caribbean region. *Mitreola* is closely allied to the recent *Enaeta barnesii* (Gray, 1825) (Plate 12, fig. 6) from Peru; this species has a typically volutid radula and is also a member of the Lyriinae.

Gosavia Stoliczka, 1866

(Plate 12, fig. 7)

Gosavia Stoliczka, 1866, Sitzb. k. k. Akad. Wiss. Wien, 52: 179. Type species by OD *Voluta squamosa* Zekeli, 1852. Upper Cretaceous of Austria (Gosau formation).

Shell moderate in size, *c.* 45mm, coniform, spire short; teleoconch of *c.* 6 angulate and steeped whorls. Sculptured with prominent, scabrous spiral cords and axial striae. Aperture longer than spire, narrow and parallel to body whorl.

Wenz (1943) and Powell (1966) suggested a placement of *Gosavia* in the family Volutidae, Pilsbry & Olsson (1954) the Turridae, and Cox (1931) assigned the genus to the Conidae. The general appearance of the species is suggestive of the Conidae.

In 1868, Stoliczka described a new species *Gosavia indica* from Cretaceous deposits of Southern India. This particular species, compared by the author to the Conidae, Volutidae and Mitridae, is a turrid species with a distinct labial sinus.

Mitrolumna Bucquoy, Dautzenberg & Dollfus, 1883

(Plate 12, figs. 8 - 9)

Mitrolumna Bucquoy, Dautzenberg & Dollfus, 1883, Mol. mar. Roussillon, 1 (3): 115, 121. Type species by OD *Mitra olivoidea* Cantraine, 1835. Recent, Mediterranean.

= 1886. *Mitrolumina* Locard, Cat. gén. moll. France, p. 542 (nom. null.)

Shell small, 5 - 30mm, ovate-biconic, whorls slightly convex. Sculptured with elevated spiral threads and occasionally longitudinal lirae. Aperture about equal in height to the spire, moderately narrow, labial lip thickened and denticulate, labial sinus shallow; columella with 2 thickened folds in adults, siphonal canal wide and open.

Cossman (1899), Palmer (1937) and Coan (1966), referred *Mitrolumna* to the Mitridae, but Thiele (1929), Wenz (1943) and Powell (1966) correctly assigned the genus to the Turridae. The columella has only 2 folds, and the labial sinus, although shallow, is nevertheless present. The family name Mitrolumnidae Sacco, 1904, becomes a synonym of Borsoniinae Bellardi, 1875.

Diptychomitra Bellardi, 1888

(Plate 12, fig. 10)

Diptychomitra Bellardi, 1888, Mem. R. Accad. Sci. Torino, 38: 152. Type species by SD (Pace, 1902) *D.eximia* Bellardi, 1888. Miocene of Italy.

Coan (1966) included *Diptychomitra* in the family Mitridae and designated *D.eximia* Bellardi as the type species of the genus; the type designation was superfluous in view of two prior designations by Pace (1902) and Palmer (1937).

Diptychomitra is a member of the mitromorphine group of Turridae and is a synonym of *Mitrolumna* Bucquoy, Dautzenberg & Dollfus, 1883. For further discussions, see Powell (1966). The subfamily name Diptychomitrinae Bellardi, 1888, becomes a synonym of Borsoniinae, Bellardi, 1875.

Clinomitra Bellardi, 1888

(Plate 12, fig. 11)

Clinomitra Bellardi, 1888, Mem. R. Accad. Sci. Torino, 38: 152. Type species by M *C.rovasendae* Bellardi, 1888. Miocene of Italy.

Coan (1966) assigned *Clinomitra* to the family Mitridae. *Clinomitra* is a genus of the mitromorphine group of Turridae and is a synonym of *Mitrolumna* Bucquoy, Dautzenberg & Dollfus, 1883. For further discussions, see Powell (1966).

Cymakra Gardner, 1937

(Plate 12, fig. 12)

Cymakra Gardner, 1937, U.S. Geol. Surv. Prof. Pap., 142F: 421. Type species by OD *C.poncei* Gardner, 1937. Lower Miocene of Florida.

Shell small, 6 - 7mm, fusiform and slender, with 5 slightly convex whorls and a protoconch of 1½ smooth nuclear whorls. Sculptured with axial folds on early whorls and prominent uniformly spaced spiral cords on all whorls. Aperture narrow, lirate within, columella with 2 folds.

Gardner (1937) originally located *Cymakra* in the family Mitridae, but Wenz (1943) assigned the genus to the *Mitromorpha-Mitrolumna* group of the Turridae. Beets (1950) included the genus in the Turridae, and suggested that *Cymakra* be combined with *Mitromorpha*. Powell (1966) preferred the original location in the Mitridae, because *Cymakra* lacked a labial sinus.

The holotype of *Cymakra poncei* is in the U.S. Geological Survey collection, USNM No. 371438; the dimensions are length 6.3mm, width 2.4mm, and the label originally read *"Mitromorpha euzona"*. The type and a paratype are both mitromorphine turrids; both specimens have a small portion of the labial lip missing, which accounts for the absence of a labial sinus.

The recent species *Mitra(Thala ?)torticula* Dall, 1889, from 400 fathoms (732 metres) off Morro, *Mitra haycocki* Dall & Bartsch, 1911 from Bermuda and *Mitra orcutti* Dall, 1920, from La Jolla, California, are mitromorphine turrids belonging to the same group as the Miocene *Cymakra poncei* Gardner.

Mitricaulis Pilsbry, 1944

(Plate 12, fig. 14)

Mitricaulis Pilsbry, 1944, Proc. Acad. Nat. Sci. Philadelphia. 96: 142. Type species by OD *M.incarum* Pilsbry, 1944. ? Eocene of Eastern Peru.

Pilsbry (1944) described *Mitricaulis incarum* from marine deposits of possible Eocene age from a point midway between Quebrada Alamira and the Isla de Macuya on the Pachitea river. The

deposits are pink limestone, and the station of the Red Beds deposits was said to have been lower than those supplying fresh water fossils. Pilsbry compared the columellar folds to *Mitra* and remarked that the deeply sinuated outer lip recalls some pleurotomid genera, particularly the species *Turris caffraria* (Griesbach).

There is a possibility that *Mitricaulis* is not a marine member, but a freshwater fossil. The species bears a resemblance to the cerithiacean genus *Sinomelania* Yen, 1936, but species of this genus as well as other cerithiacean genera, lack the prominent columellar folds. Whatever family *Mitricaulis* may belong to, it certainly is not a member of the Mitridae.

Aidone H. & A. Adams, 1853

(Plate 12, fig. 15)

Aidone H. & A. Adams, 1853, Gen. Rec. Moll., 1: 172. Type species by M *Mitra insignis* A. Adams, 1853 = *Columbella ligula* Duclos, 1835 [1840]. Recent, Indo-Pacific.

The species *Mitra insignis* was only briefly described and never illustrated. The species has been omitted from Sowerby's monograph (1874) and was only briefly mentioned by Tryon (1882). Pace (1902) was the only author who correctly assigned *Aidone* to the Columbellidae, all other workers having placed the section or subgenus in the family Mitridae.

The type specimen of *Mitra insignis* is a juvenile of *Pyrene ligula* (Duclos); the species has the characteristic "split tooth" of the Columbellidae, which is a deeply grooved columellar swelling. *Aidone* becomes a subjective synonym of *Pyrene* Röding, 1798.

Mitropsis Pease, 1868

Mitropsis Pease, 1868, Amer. J. Conch., 3: 211. Type species by M *M.fusiformis* Pease, 1868 (nom. praeocc.) = *Columbella paumotensis* Tryon, 1883 (nom. subst. pro *Mitropsis fusiformis* Pease, 1868). Recent, Pacific.

The genus was originally described in the family Mitridae, but has been allocated to the Columbellidae by all subsequent authors.

Volvaria Lamarck, 1801

(Plate 12, fig. 16)

Volvaria Lamarck, 1801, Syst. anim. s. vert., p. 93. Type species by M *V.bulloides* Lamarck, 1801. Eocene of France.

Shell small(7 - 15mm, cylindrical and slender, spire truncate and involute; whorls number *c.* 3, body whorl almost as long as the shell itself. Sculptured with spiral striae which are serrated by axial lines. Aperture very narrow and linear, parallel to columella which has 2 - 4 anteriorly placed folds.

Volvaria has at various times been assigned to the Marginellidae, Cypraeidae, Ovulidae, Acteonidae and Mitridae. Palmer (1937), Wenz (1943), Glibert (1960) and Coan (1966) retained *Volvaria* in the family Mitridae. There is not a single character which would associate *Volvaria* with the Mitridae, and the genus would be more appropriately placed in the opisthobranch superfamily Acteonacea.

Volvariella Fischer, 1883

(Plate 12, fig. 17)

Volvariella Fischer, 1883, Man. Conchyl., pt. 6: 553. Type species by M *V.lamarckii* Deshayes = *Volvaria lamarckii* Deshayes, 1865. Eocene of France.

Shell small, 7 - 15mm, cylindrical and sleal, slender, spire short and conical, with almost 5 whorls; nuclear whorls are smooth and flat. Sculptured with numerous and finely punctate spiral striae. Aperture longer than the spire, straight, slightly flaring anteriorly; columella with 2 anteriorly placed folds.

Similar to *Volvaria,* this genus was also placed in the Mitridae by Palmer (1937), Wenz (1943) and Coan (1966). Deshayes (1865) placed *Volvaria lamarckii* in the Cypraeidae, but Fischer (1883) described *Volvariella* as a genus in the Acteonidae, and listed as the monotypic representative the Paris Basin Eocene *Volvaria lamarckii* Deshayes. Coan (*loc. cit.*), erroneously cited the Recent species *Mitra lamarckii* Deshayes, 1832, as the type species of *Volvariella.* The genus should be located in the Acteonacea, close to *Cylindrites* J. de C. Sowerby.

Palaeorhaphis Stewart, 1927

Palaeorhaphis Stewart, 1927, Proc. Acad. Nat. Sci. Philadelphia, 78: 308, 419. Type species by OD *Fasciolaria pergracilis* Aldrich, 1886. L. Eocene of Alabama, S.E. United States.

Stewart (1927) and Wenz (1943) assigned the genus to the Turridae, but Powell (1966) considered *Palaeorhaphis* to be more likely volutid or possibly mitrid. The genus is similar in appearance to the Upper Cretaceous *Graphidula* Stephenson, 1941, which usually has only a single columellar fold whereas *Palaeorhaphis* has 3 weakly developed folds. A more appropriate place for *Palaeorhaphis* would be the family Fasciolariidae. For a generic diagnosis and photographs of the type species, see Powell (1966).

Perplicaria Dall, 1890

(Plate 12, fig. 13)

Perplicaria Dall, 1890, Trans. Wag. Free Inst. Sci. Philadelphia, 3 (1): 90. Type species by M *P.perplexa* Dall, 1890. Pliocene of Florida.

Shell moderately small, 13 - 18mm, fusiformly ovate, with 5 convex whorls and 1½ smooth, involute nuclear whorls. Sculptured with prominent, regular spiral threads and intersecting axial striae. Aperture elongate and narrow, labial lip patulous and dentate, columella with 2 oblique folds, siphonal notch absent.

In his original description of *Perplicaria,* Dall (1890) placed the genus between the Volutidae and Fasciolariidae. In a subsequent re-description of the species, Dall (1892) assigned *Perplicaria* to the Mitridae with some misgivings. Gardner (1937) retained *Perplicaria* in the Mitridae, but noted the resemblance of features to the cancellariid genus *Aphera* H. & A. Adams, 1854.

Wilson (1948) reviewed the systematic position of *Perplicaria* and concluded that the assignment of the genus to the Cancellariidae is most appropriate. Olsson & Harbison (1953) and subsequent writers have referred *Perplicaria* to the Cancellariidae, where the genus now rests.

PLATES 1 - 12

FAMILY MITRIDAE

PLATE 1

Fig. 1. *Mitra glabra* Swainson, 1821; cut section showing interior whorls; Melvill-Tomlin coll., NMW.

Fig. 2. *Mitra mitra* (Linnaeus, 1758). Lectotype LS, length 71.6mm, width 22.5mm. Type species of *Mitra* Lamarck, 1798.

Fig. 3. *M.papalis* (Linnaeus, 1758). Okinawa, Ryukyu Islands, leg. Withington; USNM 670982, length 104.0mm, width 34.0mm. Type species of *Tiarella* Swainson, 1840 = *Mitra* Lamarck, 1798.

Fig. 4. *M.stictica* (Link, 1807)—smooth form. Motu Iriru, Raiatea, Society Islands, leg. R. Sixberry; USNM 675374, length 46.4mm, width 18.6mm.

Fig. 5. *M.stictica* (Link, 1807)—sculptured form. Keokea, Hilo, Hawaiian Islands, leg. D. Thaanum; USNM 337964, length 52.0mm, width 18.0mm.

Fig. 6. *M.idae* Melvill, 1893. Point Loma, Lower California, leg. I. Shepherd; holotype NMW, length 60.0mm, width 19.3mm. Type species of *Atrimitra* Dall, 1918 = *Mitra* Lamarck, 1798.

Fig. 7. *M.nigra* (Gmelin, 1791). West Africa; BMNH, length 38.4mm. Type species of *Fuscomitra* Pallary, 1900, as "*M.fusca*" = *Mitra* Lamarck, 1798.

Fig. 8. *M.solida* Reeve, 1844. Sydney Harbour, Australia, ex-Capt. Comtesse; holotype of *Vicimitra prosphora* Iredale, 1929, AM C-57846, length 45.4mm, width 16.5mm. Type species of *Vicimitra* Iredale, 1929 = *Mitra* Lamarck, 1798.

Fig. 9. *M.glabra* Swainson, 1821. Holotype of *M.bulimoides* Reeve, 1845, BMNH 1966656, length 33.2mm, width 10.9mm. Type species of *Isara* H. & A. Adams, 1853 = *Mitra* Lamarck, 1798.

Fig. 10. *M.nigra* (Gmelin, 1791). Horta Fayal, Azores, U.S. Eclipse Expedition; USNM 125279, length 32.0mm, width 12.0mm.

Figs. 11 & 12. *M.chinensis* Griffith & Pidgeon, 1834. Bombay, India, leg. F. Steiner; length 34.0mm, width 12.0mm and length 37.0mm, width 13.3mm respectively (immature specimens).

Fig. 13. *M.ancillides* Broderip, 1836. Anaa I., Society Islands; holotype BMNH 1967712, length 23.8mm, width 10.6mm. Type species of *Mutyca* H. & A. Adams, 1853 = *Mitra* Lamarck, 1798.

Fig. 14. *M.coffea* Schubert & Wagner, 1829. Mauritius, Henderson coll.; USNM 305671, length 46.0mm, width 17.0mm. Type species of *Phaeomitra* Martens, 1880 = *Mitra* Lamarck, 7198.


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PLATE 2

Fig. 1. *Mitra fusiformis zonata* Marryat, 1817. Villefranche, Mediterranean; Melvill-Tomlin coll., NMW, length 70.7 mm. Type species of *Episcomitra* Monterosato, 1917 = *Mitra* Lamarck, 1798.

Fig. 2. *M.triplicata* Martens, 1904—broad form. Off Mabul I., Sibuko Bay, Borneo, in 260 fathoms (476 metres), at 45.7°F (7.5°C), U.S. Fish Commission; USNM 239084, length 58.0mm, width 20.0mm.

Fig. 3. *M. triplicata* Martens, 1904—slender form. Iligan Bay, Mindanao, Philippine Islands, in 700 fathoms (1281 metres), U.S. Fish Commission; USNM 238804, length 55.5mm, width 15.5mm.

Fig. 4. *M.nivea* Broderip, 1836. Marau Sound, Guadalcanal, Brit. Solomon Islands, leg. I. Gower; length 40.0mm, width 11.6mm (immature specimen).

Fig. 5. *M.rosacea* Reeve, 1845. Boac, Marinduque I., Philippine Islands, leg. R. Lumawig; length 31.0mm, width 11.2mm.

Fig. 6. *Mitra*(*Nebularia*)*contracta* Swainson, 1820. Off Makua, Oahu, Hawaiian Islands, in 7 fathoms (13 metres), under coral, leg. P. Burgess; length 27.8mm, width 9.0mm. Type species of *Nebularia* Swainson, 1840.

Fig. 7. *M.*(*N.*)*chrysostoma* Broderip, 1836. Jaluit Atoll, Marshall Islands, leg. H. A. Rehder; USNM 659595, length 28.0mm, width 11.0mm.

Fig. 8. *M.*(*N.*)*coronata* Lamarck, 1811. Lectotype MHNG 1102/74/2, length 26.0mm, width 10.5mm. Type species of *Chrysame* H. & A. Adams, 1853 = *Nebularia* Swainson, 1840.

Fig. 9. *M.*(*N.*)*coronata* Lamarck, 1811. Paralectotype MHNG 1102/74/1, length 23.1mm, width 10.0mm.

Fig. 10. *M.*(*N.*)*acteoglypha* Gardner, 1937. Baileys Ferry, Chipola River, Calhoun Cty., L. Miocene of Florida; length 19.0mm, width 11.6mm (from Gardner, 1937, pl. 48, fig. 5).

Fig. 11. *M.*(*N.*)*elatior* Finlay, 1924. Clifden, Southland, M. Miocene of New Zealand; paratype AIM TM-479, length 14.1mm, width 5.2mm.

Fig. 12. *M.*(*N.*)*eusulcata* Finlay, 1924. Target Gully, Oamaru, Otago, L. Miocene of New Zealand; paratype AIM TM-480, length 10.1mm, width 4.3mm.

Fig. 13. *M.*(*N.*)*avenacea* Reeve, 1845. Marau Sound, Guadalcanal, Brit. Solomon Islands, leg. I. Gower; length 13.5 mm, width 4.3mm.

Fig. 14. *M.*(*N.*)*chrysalis* Reeve, 1844. Nadroga reef, Fiji Islands, leg. author; length 17.0mm, width 9.0mm.

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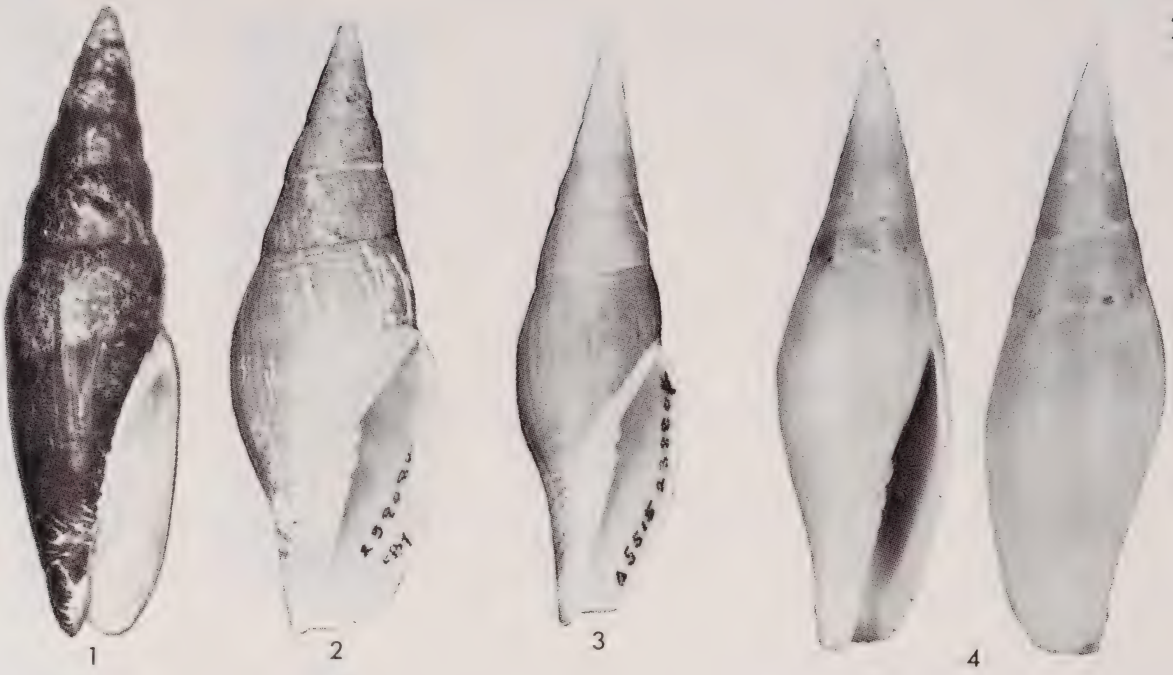

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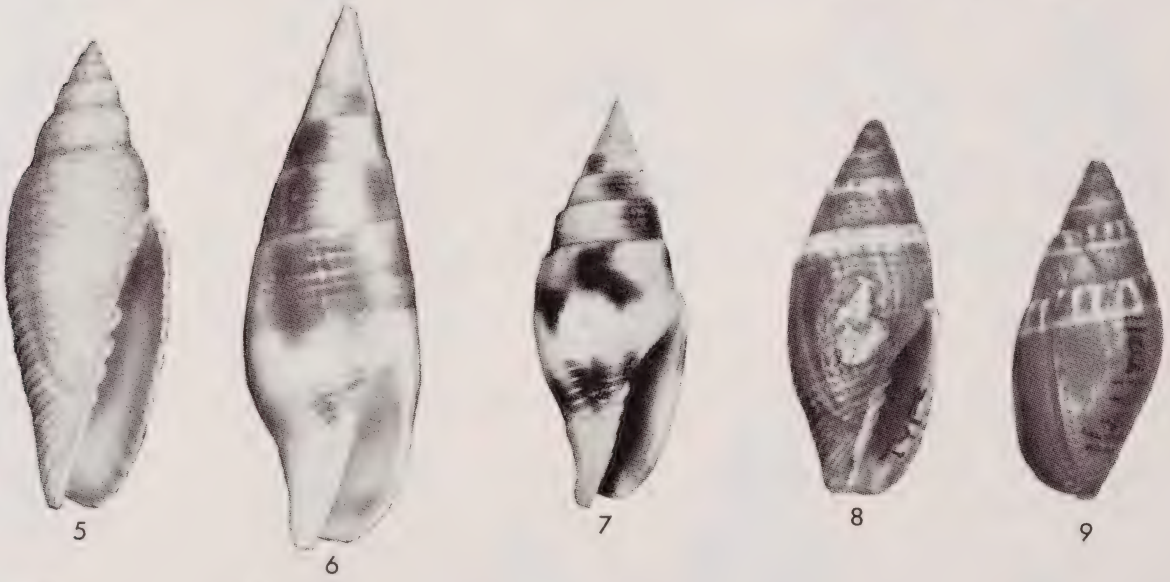

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PLATE 3

Fig. 1. *Mitra*(*Eumitra*)*alokiza* Tenison-Woods, 1880. Altona Bay, coal shaft, Miocene of Victoria, Australia; Powell coll., AIM 17445, length 54.6mm, width 13.0mm (immature specimen with 5 columellar folds). Type species of *Eumitra* Tate, 1889.

Fig. 2. *M.*(*E.*)*alokiza* Tenison-Woods, 1880. Abbatoir's bore, 400 - 500 feet, Adelaide, Pliocene of Sth Australia; AIM AM-1883, length 35.2mm, width 9.3mm (immature specimen with 1 columellar fold = *fodinalis* form).

Fig. 3. *M.*(*E.*)*diductua* Tate, 1899. Tareena, N.S.W., Miocene of Australia; paratype, length *c.* 70.0mm (from Ludbrook, 1958, pl. 4, fig. 3).

Fig. 4. *M.*(*E.*)*nitens* (Marshall, 1918). Pakaurangi Point, Kaipara Harbour, L. Miocene of New Zealand; length 26.0mm, width 8.0mm (from Marshall, 1918, pl. 18, figs. 6, 6a). Type species of *Diplomitra* Finlay, 1927 = *Eumitra* Tate, 1889.

Fig. 5. *M.*(*E.*)*waitemataensis* (Powell & Bartrum, 1929). Oneroa, Waiheke I., L. Miocene of New Zealand; holotype Powell coll., AIM TP-3756, length 41.0mm, width 18.6mm.

Fig. 6. *Mitra*(*Dibaphimitra*)*florida* Gould, 1856. Marco Islands, Florida; USNM 606965, length 47.3mm, width 21.7 mm. Type species of *Dibaphimitra* Cernohorsky, herein.

Fig. 7. *M.*(*D.*)*dennanti* Tate, 1889. Lower beds at Muddy Creek, M. Miocene of Victoria, Australia; length 33.0mm, width 16.0mm (from Tate, 1889, pl. 3, fig. 3).

Fig. 8. *M.*(*D.*)*transsylvanica* Hoernes & Auinger, 1880. Lapugy, Miocene of Hungary; length 26.5mm, width 14.0 mm (from Hoernes & Auinger, 1880, pl. 11, figs. 1a, b).

Fig. 9. *Mitra*(*Dibaphus*)*edentula* Swainson, 1823. Philippine Islands; USNM 90663, length 40.0mm, width 13.0mm. Type species of *Dibaphus* Philippi, 1847.

Fig. 10. *M.*(*D.*)*multiplicata* (Pease, 1865). Suva reef, Fiji Islands, intertidal, leg. R. F. Browne; length 13.4mm (juvenile specimen).

Fig. 11. *M.*(*D.*)*multiplicata* (Pease, 1865). Marau Sound, Guadacanal, Brit. Solomon Islands, leg. I. Gower; length 26.2mm, width 8.3mm. Type species of *Mitroidea* Pease, 1865 = *Dibaphus* Philippi, 1847.

Fig. 12. *M.*(*D.*)*multiplicata* (Pease, 1865). Barkly Island, Mauritius; holotype of *Mauritia barclayi* H. Adams, 1869, BMNH 1967933, length 44.6mm, width 13.7mm. Type species of *Mauritia* H. Adams, 1869 = *Dibaphus* Philippi, 1847.

Fig. 13. *M.*(*D.*)*crassilabra* (Gabb, 1873). Santo Domingo, U. Miocene of Dominica (from Gabb, 1873, pl. 11, fig. 5). Type species of *Plochelaea* Gabb, 1873 = *Dibaphus* Philippi, 1847.

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PLATE 4

Fig. 1. *Mitra(Strigatella)paupercula* (Linnaeus, 1758). Holotype of *M.zebra* Lamarck, 1811; MHNG 1102/75, length 35.9mm, width 15.3mm. Type species of *Strigatella* Swainson, 1840.

Fig. 2. *M.(S.)decurtata* Reeve, 1844. Yewalu reef, N.W. of Lautoka, Fiji Islands, intertidal under coral, leg. author; length 29.5mm, width 16.5mm.

Fig. 3. *M.(S.)colombelliformis* Kiener, 1838. Rarotonga, Cook Islands, leg. M. Coppell; length 32.5mm, width 16.8mm.

Fig. 4. *M.(S.)pellisserpentis* Reeve, 1844—broad form. Head of Taiohae Bay, Nukuhiva, Marquesas, leg. R. Sixberry; USNM, length 28.0mm, width 10.8mm.

Fig. 5. *M.(S.)pellisserpentis* Reeve, 1844—slender form. Head of Taiohae Bay, Nukuhiva, Marquesas, leg. R. Sixberry; USNM, length 21.7mm, width 7.3mm.

Fig. 6. *Paleofusimitra elongata* Sohl, 1963. Ripley formation, U. Cretaceous of Mississippi; length 20.7mm, width 6.3mm (from Sohl, 1963, pl. 89, fig. 11). Type species of *Paleofusimitra* Sohl, 1963.

Fig. 7. *P.elongata* Sohl, 1963. Ripley formation, U. Cretaceous of Mississippi; holotype USNM 130468, length 20.7 mm, width 6.3mm.

Fig. 8. *Charitodoron euphrosyne* Tomlin, 1932. Off Cape Point, Sth. Africa, in 660 - 700 fathoms (1208 - 1281 metres), ex-Cape Town Museum; BMNH A-7202, length 27.4mm, width 9.5mm and length 27.4mm, width 9.1mm respectively Type species of *Charitodoron* Tomlin, 1932.

Fig. 9. *Dentimitra circumcisa* (Beyrich, 1854). Westeregeln, L. Oligocene of Germany; length 9.2mm, width 4.4mm (from Koenen, 1890, pl. 36, figs. 12b, c). Type species of *Dentimitra* Koenen, 1890.

Fig. 10. *D.impressa* (Koenen, 1890) (non Anton, 1839). Lattorf, L. Oligocene of Germany; length 14.4mm, width 6.1mm (from Koenen, 1890, pl. 36, figs. 10b, c).

Fig. 11. *D.rustica* (Martin, 1931). Nanngulan, Java, U. Eocene of Indonesia; length 14.0mm (after Martin, 1931, pl. 3, fig. 7). Type species of *Puruiana* Martin, 1931 = *Dentimitra* Koenen, 1890.

Fig. 12. *Pterygia dactylus* (Linnaeus, 1767). Holotype LS, length 30.5mm, width 17.9mm. Type species of *Pterygia* Röding, 1798.

Fig. 13. *P.crenulata* (Gmelin, 1791). Suva reef, Sth. Viti Levu, Fiji Islands, leg. author; length 27.0mm, width 12.0 mm. Type species of *Cylindromitra* Fischer, 1884 = *Pterygia* Röding, 1798.

Fig. 14. *P.nucea* (Gmelin, 1791). Sobe, Okinawa, Ryukyu Islands; USNM 670564, length 51.0mm, width 24.0mm. Type species of *Acuticylindra* Iredale, 1929 = *Pterygia* Röding, 1798.

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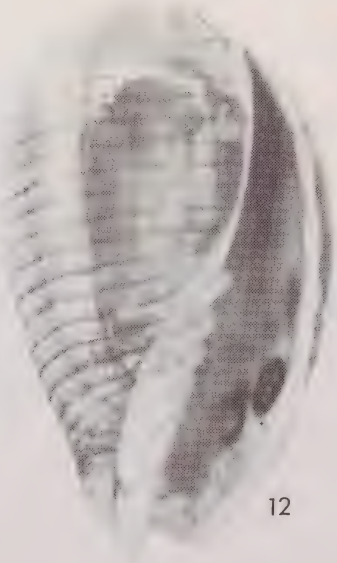

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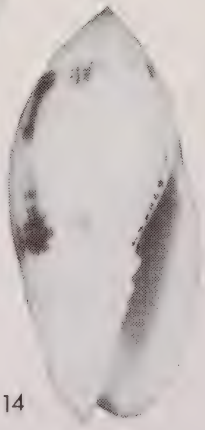

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PLATE 5

Fig. 1. *Pterygia arctata* (Sowerby, 1874). Marau Sounds, Guadalcanal, Brit. Solomon Islands, leg. I. Gower; length 19.0mm.

Fig. 2. *P.conus* (Gmelin, 1791). Philippine Islands, leg. W. H. Dall; USNM 42884, length 34.4mm, width 17.0mm.

Fig. 3. *Imbricaria*(*Imbricaria*)*conularis* (Lamarck, 1811). Society Islands, leg. A. Garrett; USNM 42269, length 22.0 mm, width 11.0mm. Type species of *Imbricaria* Schumacher, 1817.

Fig. 4. *I.*(*I.*)*vanikorensis* (Quoy & Gaimard, 1833). Okinawa, Ryukyu Islands, leg. Withington; USNM 670790, length 18.0mm, width 9.0mm.

Fig. 5. *I.*(*I.*)*conovula* (Quoy & Gaimard, 1833). Nuku'alofa, Tonga Islands, leg. H. C. Gay; length 14.5mm.

Fig. 6. *I.*(*I.*)*chiloensis* (Philippi, 1887). Cueva de Cucao, Chiloé Island, Mio/Pliocene of Chile; length 25.0mm, width 13.0mm (from Philippi, 1887, pl. 8, fig. 7).

Fig. 7. *Imbricaria*(*Sohlia*)*conoidea* (Matheron, 1843). Port de Figuières, Rhône Basin, U. Cretaceous of France; length 26.0mm, width 10.0mm (from Matheron, 1843, pl. 40, fig. 19). Type species of *Sohlia* Cernohorsky, herein.

Fig. 8. *Scabricola*(*Scabricola*)*variegata* (Gmelin, 1791). Holotype of *Mitra serpentina* Lamarck, 1811, MHNG 1107/100, length 33.9mm, width 12.0mm. Type species of *Scabricola* Swainson, 1840.

Fig. 9. *S.*(*S.*)*variegata* (Gmelin, 1791). Batangas Bay, Philippine Islands, 1 - 2 fathoms (2 - 4 metres), in sand, leg. A. Deynzer; length 34.3mm, width 12.1mm.

Fig. 10. *S.*(*S.*)*desetangsii* (Kiener, 1838). Nananu-i-Ra I., Fiji Islands, leg. author; length 29.4mm, width 12.2mm.

Fig. 11. *S.*(*S.*)*caerulea* (Reeve, 1844). Nananu-i-Ra I., Fiji Islands, in sand, intertidal, leg. author; length 30.6mm, width 12.6mm.

Fig. 12. *S.*(*S.*)*ocellata* (Swainson, 1831). Schoal Point, Mackay, Queensland, Australia, intertidal, leg. M. Elborne; length 29.8mm, width 9.7mm.

Fig. 13. *S.*(*S.*)*padangensis* (Thiele, 1925). Lami, Sth. Viti Levu, Fiji Islands, in muddy sand, intertidal, leg. E. Gardner; length 15.7mm, width 6.3mm.

Fig. 14. *Scabricola*(*Swainsonia*)*fusca* (Swainson, 1824). Mauritius, leg. E. Couacaud; length 18.8mm, width 7.0mm.

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PLATE 6

Fig. 1. *Scabricola*(*Swainsonia*)*fissurata* (Lamarck, 1811). Henderson coll., USNM 303870, length 40.0mm, width 11.0 mm. Type species of *Swainsonia* H. & A. Adams, 1853.

Fig. 2. *S.*(*S.*)*fissurata* (Lamarck, 1811). Mauritius, leg. E. Couacaud; length 25.0mm (immature specimen).

Fig. 3. *Pseudocancilla restifera* Staadt in Cossmann, 1913. Jonchery-sur-Vesle, Paris Basin, U. Paleocene of France; length 18.0mm, width 6.0mm (from Cossmann, 1913, pl. 3, fig. 202 - 24). Type species of *Pseudocancilla* Staadt in Cossmann, 1913.

Fig. 4. *Subcancilla sulcata* (Swainson in Sowerby, 1825). Agua Verde Bay, Gulf of California; USNM 266329, length 24.7mm, width 9.1mm. Type species of *Subcancilla* Olsson & Harbison, 1953.

Fig. 5. *S.annulata* (Reeve, 1844). Wadigi I., Fiji Islands, in sand, intertidal, leg. author; length 24.0mm, width 8.8mm.

Fig. 6. *S.abyssicola* (Schepman, 1913). Off Capitancillo I., Nth Cebu, Philippine Islands, in 182 fathoms (333 metres), at 55.7°F (13°C), U.S. Fish Commission; USNM 287815, length 41.8mm, width 12.0mm.

Fig. 7. *S.abyssicola* (Schepman, 1913). S.E. of Pt. Tañon, Cebu, Philippine Islands, in 310 fathoms (567 metres), at 53.3°F (12°C), U.S. Fish Commission; USNM 238888, length 26.0mm, width 7.4mm (juvenile specimen).

Fig. 8. *Ziba carinata* (Swainson, 1824). Freetown, Sierra Leone, West Africa, in 10 metres (5 fathoms), leg. A. Longhurst; MCZ 214123, length 30.0mm, width 9.3mm. Type species of *Ziba* H. & A. Adams, 1853.

Fig. 9. *Z.carinata* (Swainson, 1824). Sierra Leone, West Africa; ANSP 28664, length 19.6mm, width 6.1mm.

Fig. 10. ? *Z.bacillum* (Lamarck), 1811. Viti Levu Bay, Fiji Islands, in sand, intertidal, leg. author; length 30.0mm, width 9.5mm.

Fig. 11. *Z.flammea* (Quoy & Gaimard, 1833). Mauritius, in 10 fathoms (18 metres), leg. E. Couacaud; length 22.3 mm, width 8.0mm.

Fig. 12. *Z.fulgetrum* (Reeve, 1844). Suva reef, Fiji Islands, in sand, intertidal, leg. author; length 16.6mm, width 6.0mm.

Fig. 13. *Cancilla isabella* (Swainson, 1831). Boshu, Japan, leg. Hirase; USNM 343716, length 80.0mm, width 21.0mm. Type species of *Cancilla* Swainson, 1840.

Fig. 14. *C.scrobiculata* (Brocchi, 1814). Soos, near Bad Voslau, Vienna Basin, Miocene of Austria; Powell coll., AIM 10887, length 46.4mm, width 12.2mm.

Fig. 15. *C.scrobiculata crosnieri* Cernohorsky, 1970. Point Noire, Congo, West Africa, in 135 metres (74 fathoms). Holotype Delaware Museum of Natural History No. 22392, length 73.1mm, width 18.5mm.

Fig. 16. *C.scrobiculata crosnieri* Cernohorsky, 1970. Point Noire, Congo, West Africa, in 150 metres (82 fathoms); ANSP, length 88.0mm, width 21.3mm.

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PLATE 7

Fig. 1. *Cancilla sieversi* (Rutsch, 1934). Punta Gavilan, U. Miocene of Nth. Venezuela; length 95.0mm, width 26.0mm (from Rutsch, 1934, pl. 6, fig. 6).

Fig. 2. *C.aegra* (Reeve, 1845). "Australia"; syntype of *Mitra peasei* Dohrn, 1861, ex-Cuming coll., BMNH 1967832, length 36.8mm, width 11.0mm.

Fig. 3. *Cancilla(Fusimitra)conquisita millingtoni* (Conrad in Wailes). Jackson, Mississippi, Eocene of S.E. United States; length 87.0mm, width 23.0mm (from Harris & Palmer, 1947, pl. 55, fig. 5). Type species of *Fusimitra* Conrad, 1855.

Fig. 4. *Cancilla(Domiporta)filaris* (Linnaeus, 1771). Lomalagi, Sth. Viti Levu, Fiji Islands, in sand, intertidal, leg. author; length 24.7mm, width 10.1mm. Type species of *Domiporta* Cernohorsky herein.

Fig. 5. *C.(D.)praestantissima* (Röding, 1798). Marau Sound, Guadalcanal, Brit. Solomon Islands, leg. I. Gower; length 32.5mm, width 9.6mm.

Fig. 6. *C.(D.)carnicolor* (Reeve, 1844). Lomalagi, Sth. Viti Levu, Fiji Islands, in sand, intertidal, leg. author; length 17.4mm, width 5.5mm.

Fig. 7. *C.(D.)granatina* (Lamarck, 1811). Bauan, Batangas Bay, Philippine Islands, leg. A. Deynzer; length 45.6mm, width 14.0mm.

Fig. 8. *Neocancilla papilio* (Link, 1807)—broad form. Lomalagi, Sth. Viti Levu, Fiji Islands, in sand, intertidal, leg. author; length 36.0mm, width 14.0mm. Type species of *Neocancilla* Cernohorsky, 1966.

Fig. 9. *N.papilio* (Link, 1807)—slender form. Lomalagi, Sth. Viti Levu, Fiji Islands, in sand, intertidal, leg. author; length 50.7mm, width 15.7mm.

Fig. 10. *N.clathrus* (Gmelin, 1791). Akuilau Island, Fiji Islands, in sand, intertidal, leg. author; length 21.3mm, width 7.8mm.

Fig. 11. *N.waikikiensis* (Pilsbry, 1921). Off Keehi Lagoon, Oahu, Hawaiian Islands, in 70 fathoms (128 metres), on coral rubble; length 13.2mm, width 4.8mm.

Fig. 12. *N.takiisaoi* (Kuroda & Sakurai in Kuroda, 1959). One mile N.W. of Pitcairn Island, in 55 - 65 fathoms (101-119 metres), stones and coral rubble, Pele Expedition; USNM, length 43.7mm, width 13.3mm.

Fig. 13. *Mesorhytis gracilenta* (Meek, 1876). Yellowstone River, Missouri, U. Cretaceous of S.E. United States; length 27.3mm, width 9.5mm (from Meek, 1876, fig. 45). Type species of *Mesorhytis* Meek, 1876.

Fig. 14. *M.ripleyana* (Wade, 1926). Ripley formation, Tennessee, U. Cretaceous of S.E. United States; holotype USNM 32865, length 26.5mm, width 8.5mm. Type species of *Mitridomus* Sohl, 1963 = *Mesorhytis* Meek, 1876.

Fig. 15. *M.dacotensis* (Stanton, 1921). Cannonball formation, Dacota, Paleocene of Nth. United States; holotype length 38.0mm, width 12.0mm (from Stanton, 1921, pl. 8, fig. 13).

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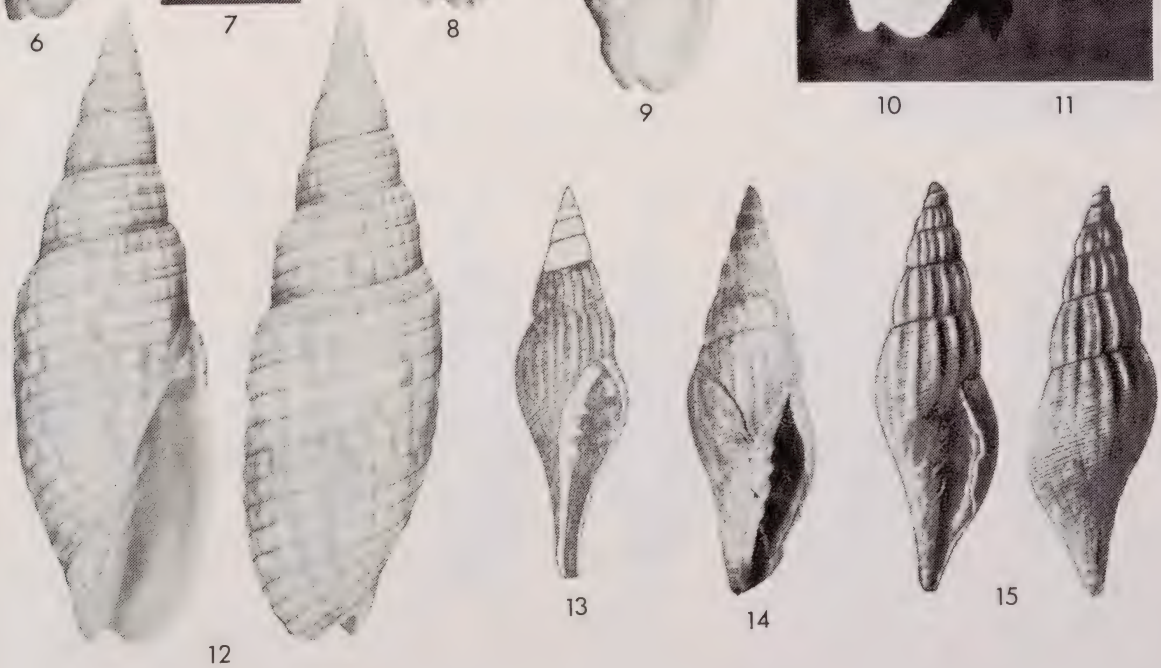

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PLATE 8

Fig. 1. *Mesorhytis dacotensis* (Stanton, 1921). Cannonball formation, Dakota, Paleocene of N. United States; paratype length 15.0mm, width 5.3mm (from Stanton, 1921, pl. 8, fig. 14).

Fig. 2. *M.arrialoorensis* (Stoliczka, 1868). Comarapolliam, Arialoor, U. Cretaceous of Sth. India (from Stoliczka, 1868, pl. 9, fig. 15).

Fig. 3. *M.cassisiana* (d'Orbigny, 1850). Gosau, Tyrol, U. Cretaceous of Austria; length 30.0mm, width 9.0mm (from Zekeli, 1852, pl. 13, fig. 14).

Fig. 4. *Vexillum*(*Vexillum*)*vulpecula* (Linnaeus, 1758). Holotype LS, length 51.0mm, width 16.7mm. Type species of *Turris* Montfort, 1810 (non Röding, 1798), *Vulpecula* Defrance in Blainville, 1824 (non Jarocki, 1822) and *Turricula* Cossman, 1899 (non Schumacher, 1817) = *Vexillum* Röding, 1798.

Fig. 5. *V.*(*V.*)*plicarium* (Linnaeus, 1758). Holotype LS, length 44.0mm, width 17.7mm (immature specimen). Type species of *Vexillum* Röding, 1798.

Fig. 6. *V.*(*V.*)*plicarium* (Linnaeus, 1758). Chance I., Thailand, Te Vega "A" Expedition; USNM 661276, length 48.0mm, width 21.0mm.

Fig. 7. *V.*(*V.*)*rugosum* (Gmelin, 1791). Sibuan I., Nth. Borneo, Indonesia, leg. M. Saul; USNM 633479, length 46.0 mm, width 20.0mm. Type species of *Tiara* Swainson, 1831 = *Vexillum* Röding, 1798.

Fig. 8. *V.*(*V.*)*mirabilis* (A. Adams, 1853). Nuku'alofa, Tonga Islands, leg. H. C. Gay; length 42.0mm.

Fig. 9. *V.*(*V.*)*isaoi* (Kuroda & Sakurai in Kuroda, 1959). Off Tosa, Japan; length 69.0mm, width 15.8mm (from Kuroda, 1959, fig. 1). Type species of *Tosapusia* Azuma, 1965 = *Vexillum* Röding, 1798.

Fig. 10. *Vexillum*(*Costellaria*)*semifasciatum* (Lamarck, 1811). Loo Choo Islands, Japan, leg. Hirase; USNM 273181, length 20.0mm. Type species of *Costellaria* Swainson, 1840.

Fig. 11. *V.*(*C.*)*sanguisugum* (Linnaeus, 1758). Nenon I., New Caledonia, leg. B. Katchor; USNM 693577, length 38.0mm, width 11.0mm. Type species of *Pulchritima* Iredale, 1929 = *Costellaria* Swainson, 1840.

Fig. 12. *V.*(*C.*)*sanguisugum* (Linnaeus, 1758). Sibuan I., N. Borneo, Indonesia; leg. M. Saul; USNM 657649, length 17.0mm, width 7.0mm (juvenile specimen).

Fig. 13. *V.*(*C.*)*polygonum* (Gmelin, 1791). Kashiwajima, Tosa, Japan, leg. Azuma; length 26.0mm, width 8.3mm.

Fig. 14. *V.*(*C.*)*antegressum* (Bellardi, 1887). Pareto, L. Miocene of Italy; length 20.0mm, width 6.0mm (from Bellardi, 1887, pl. 5, fig. 21a). Type species of *Uromitra* Bellardi, 1887 = *Costellaria* Swainson, 1840.

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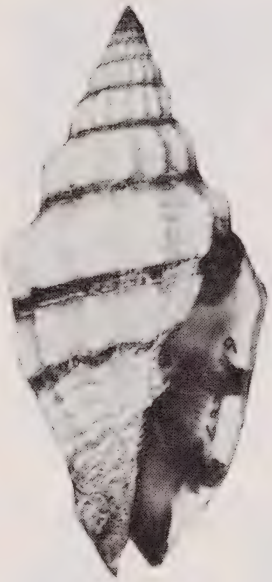

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PLATE 9

Fig. 1. *Vexillum(Costellaria)cupressinum* (Brocchi, 1814). Pliocene of Italy; length 19.0mm, width 5.6mm (from Brocchi, 1814, pl. 4, fig. 6).

Fig. 2. *V.(C.)lacertosum* Cernohorsky, herein. Lower beds at Muddy Creek, Victoria, M. Miocene of Australia; length 8.5mm, width 4.5mm (from Tate, 1889, pl. 5, fig. 2—as *Mitra paucicostata*). Type species of *Balcomitra* Finlay, 1927 = *Costellaria* Swainson, 1840.

Fig. 3. *V.(C.)leptaleum* (Tate, 1889). Lower beds at Muddy Creek, Victoria, M. Miocene of Australia; length 16.0 mm, width 5.0mm (from Tate, 1889, pl. 5, fig. 3).

Fig. 4. *V.(C.)exasperatum* (Gmelin, 1791)—broad form with distant axial ribs. Bikini I., Marshall Islands, leg. J. P. Morrison; USNM 583647, length 22.9mm. Type species of *Arenimitra* Iredale, 1929 = *Costellaria* Swainson, 1840.

Fig. 5. *V.(C.)exasperatum* (Gmelin, 1791)—slender form with numerous axial ribs. Ryukyu Islands, leg. Hirase; USNM 343745, length 25.0mm, width 9.0mm.

Fig. 6. *V.(C.)kalimnanense* Cernohorsky, herein. Upper beds at Muddy Creek, Victoria, Pliocene of Australia; AIM, length 16.1mm, width 5.6mm.

Fig. 7. *V.(C.)obeliscus* (Reeve, 1844). Sydney Harbour, N.S.W., Australia, Capt. Comtesse; holotype of *Mitropifex quasillus* Iredale, 1929, AM, C-57857, length 30.1mm, width 10.8mm. Type species of *Mitropifex* Iredale, 1929 = *Costellaria* Swainson, 1840.

Fig. 8. *V.(C.)cruentatum* (Gmelin, 1791). Marau Sound, Guadalcanal, Brit. Solomon Islands, leg. I. Gower; length 18.7mm, width 7.4mm.

Fig. 9. *V.(C.)albotaeniatum* (Hervier, 1898). Albert Cove, N.W. Rabi I., Vanua Levu, Fiji Islands, intertidal, leg. R. Jameson; USNM 695177, length 13.5mm, width 4.6mm.

Fig. 10. *V.(C.)etremoides* (Finlay, 1924). Target Gully, Oamaru, Otago, L. Miocene of New Zealand; holotype AIM, TM-818, length 11.1mm, width 4.2mm.

Fig. 11. *Vexillum(Pusia)microzonias* (Lamarck, 1811). Suva reef, Fiji Islands, intertidal, leg. author; length 20.0mm, width 8.4mm. Type species of *Pusia* Swainson, 1840.

Fig. 12. *V.(P.)paraleucozonum* (Boettger, 1906). Kostej, Banat, Miocene of Hungary (from Zilch, 1934, pl. 17, fig. 18).

Fig. 13. *V.(P.)ebenus* (Lamarck, 1811)—typical, smooth form. Mediterranean; USNM 253555, length 26.0mm, width 10.0mm. Type species of *Ebenomitra* Monterosato, 1917 = *Pusia* Swainson, 1840.

Fig. 14. *V.(P.)ebenus* (Lamarck, 1811)—slender, costate form. Mediterranean; USNM 305620, length 25.8mm (forma *plicatula* Brocchi, 1814).

Fig. 15. *V.(P.)ebenus* (Lamarck, 1811)—broad, costate form. Mediterranean; USNM 189120, length 19.0mm (forma *plumbea* Lamarck, 1811).

Fig. 16. *V.(P.)tricolor* (Gmelin, 1791)—smooth, slender form. Adriatic Sea; USNM 189116, length 8.0mm, width 3.0mm. Type species of *Pusiolina* Cossmann, 1921 = *Pusia* Swainson, 1840.

Fig. 17. *V.(P.)tricolor* (Gmelin, 1791)—broad, costate form. Algeria; USNM 305665, length 9.0mm, width 3.7mm.

Fig. 18. *V.(P.)tricolor* (Gmelin, 1791)—slender, costate form. Ragusa, Dalmatia, Adriatic Sea; USNM 179373, length 6.5mm, width 2.5mm.

Fig. 19. *V.(P.)turben* (Reeve, 1844). Philippine Islands; syntype ex-Cuming coll., BMNH 1967900, length 17.8mm, width 8.9mm. Type species of *Idiochila* Pilsbry, 1921 = *Pusia* Swainson, 1840.

Fig. 20. *V.(P.)cavea* (Reeve, 1844). Syntype ex-Cuming coll., BMNH 1967707, length 17.3mm, width 9.6mm.

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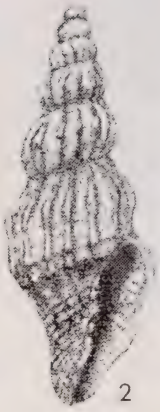
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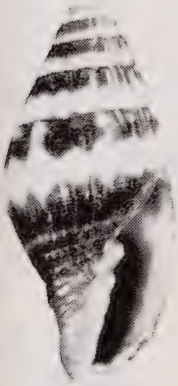
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PLATE 10

Fig. 1. *Vexillum(Pusia)luculentum* (Reeve, 1845). Viti Levu Bay, N.E. Viti Levu, Fiji Islands, intertidal, leg. author; length 11.8mm, width 6.2mm.

Fig. 2. *V.(P.)consanguineum* (Reeve, 1845). Namoui, Niue Island, leg. N. McDowall; length 16.5mm, width 9.3mm.

Fig. 3. *V.(P.)cancellarioides* (Anton, 1839). Namoui, Niue Island, leg. N. McDowall; length 18.7mm, width 12.0mm.

Fig. 4. *V.(P.)leucodesmum* (Reeve, 1845). Albert Cove, N.W. Rabi I., Vanua Levu, Fiji Islands, leg. R. Jameson; USNM 695238, length 13.0mm, width 6.6mm.

Fig. 5. *Austromitra rubiginosa* (Hutton, 1873). Mt. Maunganui, Tauranga, New Zealand, leg. F. Flinn; length 8.2mm, width 3.6mm (form with angulate whorls). Type species of *Austromitra* Finlay, 1927.

Fig. 6. *A.rubiginosa* (Hutton, 1873). Whangarei Heads, New Zealand, leg. C. Cooper; length 10.9mm, width 4.5mm (forma *antipoda* Brookes, 1926).

Fig. 7. *A.rubiginosa* (Hutton, 1873). Whangaroa Harbour, New Zealand, leg. C. Cooper; length 12.8mm, width 5.7mm (form with convex whorls).

Fig. 8. *A.rubiginosa* (Hutton, 1873). Whangaroa Harbour, New Zealand; holotype of *A.rubiradix* Finlay, 1927, AIM, TM-70, length 8.4mm, width 4.3mm, height of aperture 5.3mm.

Fig. 9. *A.rubiginosa* (Hutton, 1873). Wanganui, U. Pleistocene of New Zealand, Drew coll.; holotype of *Turricula planata* Hutton, 1885, CM M-3142, length 14.5mm, width 6.2mm, height of aperture 7.7mm.

Fig. 10. *A.rubiginosa* (Hutton, 1873). Off Cuvier Island, New Zealand, 38 fathoms (70 metres); holotype of *A.planatella* Finlay, 1930, AIM, TM-69, length 10.7mm, width 4.7mm, height of aperture 5.4mm.

Fig. 11. *A.quenelli* Fleming, 1943. Palliser Bay, Wellington, L. Pliocene of New Zealand; AIM AM-9660, length 10.6mm, width 5.2mm.

Fig. 12. *Zierliana ziervogelii* (Gmelin, 1791). Holotype of *Cancellaria ziervogeliana* Lamarck, 1822, MHNG 1108/6, length 25.2mm, width 16.2mm. Type species of *Zierliana* Gray, 1847.

Fig. 13. *Z.oleacea* (Reeve, 1844). Guijulugan, Island of Negros, Philippine Islands, on shore, leg. P. Bartsch; USNM 232017, length 24.3mm, width 12.3mm.

Fig. 14. *Z.woldemarii* (Kiener, 1838)—plicate, broad form. Manava I., N. Viti Levu, Fiji Islands, intertidal, leg. author; length 20.0mm, width 10.8mm.

Fig. 15. *Z.woldemarii* (Kiener, 1838)—smooth, broad form. Philippine Islands; USNM 303899, length 20.6mm, width 10.1mm.

Fig. 16. *Z.simplicissima* (Martin, 1880). Java, Miocene of Indonesia (from Martin, 1880, pl. 5, fig. 3—as *Marginella simplicissima*).

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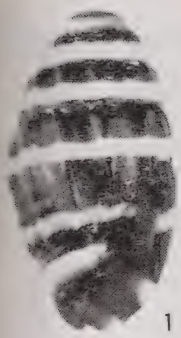
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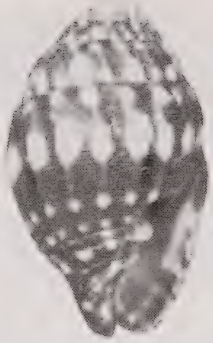
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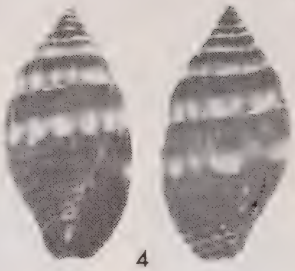
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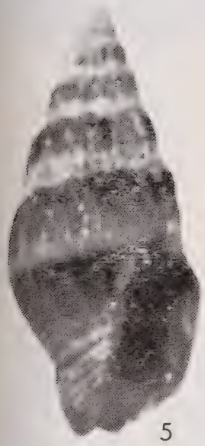
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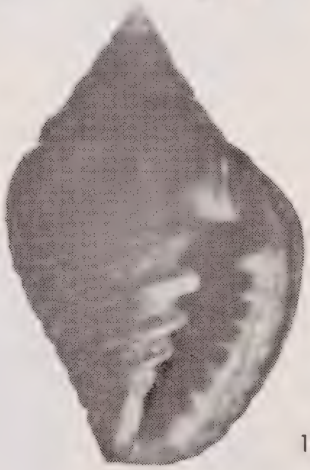
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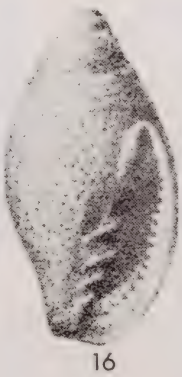
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PLATE 11

Fig. 1. *Thala mirifica* (Reeve, 1845). Island of Capul, Philippine Islands; syntype ex-Cuming coll., BMNH 1966655, length 10.1mm, width 3.2mm. Type species of *Thala* H. & A. Adams, 1853 (part of siphonal canal missing in figured specimen).

Fig. 2. *T.mirifica* (Reeve, 1845). Island of Capul, Philippine Islands; syntype of *Mitra recurva* Reeve, 1845, ex-Cuming coll., BMNH 1967856, length 9.3mm, width 2.9mm.

Fig. 3. *T.exilis* (Reeve, 1845). Island of Ticao, Philippine Islands; syntype ex-Cuming coll., BMNH 1967753, length 10.9mm, width 3.7mm.

Fig. 4. *T.gratiosa* (Reeve, 1845). Panama; holotype of *Mitra solitaria* C. B. Adams, 1852, MCZ 186351, length 16.9 mm, width 6.3mm (from Turner, 1956, pl. 5, fig. 1). Type species of *Mitromica* Berry, 1958 = *Thala* H. & A. Adams, 1853 (immature specimen).

Fig. 5. *T.gratiosa* (Reeve, 1845). St. Lucas, W. coast of Lower California; USNM, length 9.5mm, width 3.3mm.

Fig. 6. *T.obsoleta* (Brocchi, 1814). Volterra, Miocene of Italy; length 8.0mm, width 3.0mm (from Bellardi, 1888, pl. 6, fig. 49a) (immature specimen).

Fig. 7. *T.obsoleta* (Brocchi, 1814). Rio della Batteria, Miocene of Italy; holotype of *Micromitra taurina* Bellardi, 1888; length 8.0mm, width 2.5mm (from Bellardi, 1888, pl. 6, fig. 42a — juvenile specimen). Type species of *Micromitra* Bellardi, 1888 = *Thala* H. & A. Adams, 1853.

Fig. 8. *T.lapugyensis* (Hoernes & Auinger, 1880). Steinabrunn, Miocene of Austria; length 8.0mm, width 2.5mm (from Hoernes & Auinger, 1880, pl. 10, fig. 22).

Fig. 9. *Pyrenomitra anachis* Eames, 1952. Rakhi Nala. U. Eocene of Pakistan; length 3.1mm, width 1.9mm (from Eames, 1952, pl. 5, fig. 102, 103). Type species of *Pyrenomitra* Eames, 1952.

Fig. 10. *Butonina nudata* Beets, 1943. Buton Island, U. Oligocene of Indonesia; length 34.0mm (from Beets, 1943, pl. 28, figs. 73, 74). Type species of *Butonina* Beets, 1943.

Fig. 11. *Voluta carolinensis* Conrad, 1840. Duplin County, U. Miocene of Nth. Carolina; length 73.0mm, width 24.0 mm (from Gardner, 1937, pl. 48, fig. 8). Type species of *Pleioptygma* Conrad, 1863.

Fig. 12. *Clifdenia turneri* Laws, 1932. Clifden, Southland, M. Miocene of New Zealand; holotype AIM TM-177, length 151.3mm, width 48.0mm, height of aperture 87.0mm. Type species of *Clifdenia* Laws, 1923.

Fig. 13. *Voluta patagonica* Ihering, 1897. Patagonia, Miocene of Sth. America; length 30.0mm, width 13.0mm (from Ihering, 1897, pl. 3, fig. 6). Type species of *Neoimbricaria* Ihering, 1907.

Fig. 14. *Mitra dumosa* Conrad in Wailes, 1854. Jackson, Mississippi, Eocene of S.E. United States (from Wailes, 1854, pl. 15, fig. 4). Type species of *Lapparia* Conrad, 1855.

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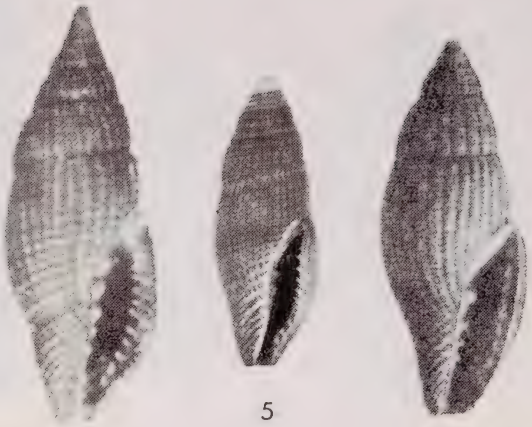

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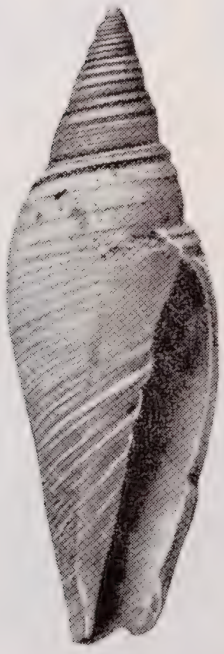

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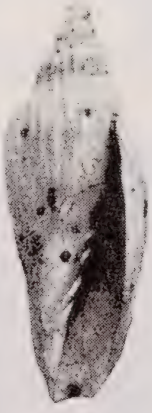

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PLATE 12

Fig. 1. *Egestas waitei* (Suter, 1909). Otago Heads, Sth. Island, New Zealand, 60 fathoms (110 metres); AIM. length 7.2mm, width 3.1mm. Type species of *Egestas* Finlay, 1927.

Fig. 2. *E.waitei* (Suter, 1909). Cape Saunders, Otago, Sth. Island, New Zealand, 40 - 50 fathoms (72 - 92 metres); AIM 17927, length 7.0mm, width 3.0mm.

Fig. 3. *E.fenestrata* (Suter, 1917). Pukeuri, Oamaru, L. Miocene of New Zealand; topotype AIM 9584, length 7.6mm, width 2.8mm.

Fig. 4. *Mitra monodonta* Lamarck, 1803. Grignon, Paris Basin, Eocene of France (from Swainson, 1833, pl. 128, fig. 1). Type species of *Mitreola* Swainson, 1833.

Fig. 5. *Mitreola americana* (Dall, 1915). Chipola formation, L. Miocene of Florida; holotype length 28.0mm (from Pilsbry & Olsson, 1954, pl. 3, fig. 3).

Fig. 6. *Voluta barnesii* Gray, 1825. Peru; holotype of *V.harpa* Barnes, 1824, length 30.5mm, width 17.0mm (from Barnes, 1824, pl. 9, fig. 4). Type species of *Enaeta* H. & A. Adams, 1853.

Fig. 7. *Voluta squamosa* Zekeli, 1852. Gosau, U. Cretaceous of Austria; length 45.0mm, width 23.0mm (from Zekeli, 1852, pl. 14, fig. 1). Type species of *Gosavia* Stoliczka, 1866.

Fig. 8. *Mitra olivoidea* Cantraine, 1835. Mediterranean; lectotype IRSN, length 8.3mm, width 4.1mm. Type species of *Mitrolumna* Bucquoy, Dautzenberg & Dollfus, 1883 (photo Institut Royal des Sciences Naturelles de Belgique, Brussels).

Fig. 9. *M.olivoidea* Cantraine, 1835. Mediterranean; IRSN, length 5.4mm, width 2.7mm—axially ribbed form (photo Institut Royal des Sciences Naturelles de Belgique, Brussels).

Fig. 10. *Diptychomitra eximia* Bellardi, 1888. Termo-fourà, M. Miocene of Italy; length 19.0mm, width 9.0mm (from Bellardi, 1888, pl. 6, fig. 52a). Type species of *Diptychomitra* Bellardi, 1888 = *Mitrolumna* Bucquoy, Dautzenberg & Dollfus, 1883.

Fig. 11. *Clinomitra rovasendae* Bellardi, 1888. Termo-fourà, M. Miocene of Italy; length 29.0mm, width 12.0mm (from Bellardi, 1888, pl. 6, fig. 51a). Type species of *Clinomitra* Bellardi, 1888 = *Mitrolumna* Bucquoy, Dautzenberg & Dollfus, 1883.

Fig. 12. *Cymakra poncei* Gardner, 1937. Chipola River, L. Miocene of Florida; length 6.5mm, width 2.4mm (from Gardner, 1937, pl. 41, fig. 37). Type species of *Cymakra* Gardner, 1937.

Fig. 13. *Perplicaria perplexa* Dall, 1890. Caloosahatchie, Pliocene of Florida; length 17.8mm (from Dall, 1892, pl. 13, fig. 4). Type species of *Perplicaria* Dall, 1890.

Fig. 14. *Mitricaulis incarum* Pilsbry, 1944. Pachitea River, ? Eocene of Eastern Peru; length 17.0mm (from Pilsbry, 1944, pl. 10, fig. 13). Type species of *Mitricaulis* Pilsbry, 1944.

Fig. 15. *Mitra insignis* A. Adams, 1853; Rains Island, Pacific; holotype BMNH 1966465, length 16.8mm, width 6.4 mm. Type species of *Aidone* H. & A. Adams, 1853 = *Pyrene* Röding, 1798.

Fig. 16. *Volvaria bulloides* Lamarck, 1801. Grignon, Paris Basin, Eocene of France (from Cossmann, 1899, pl. 8, fig. 22). Type species of *Volvaria* Lamarck, 1801.

Fig. 17. *Volvaria lamarckii* Deshayes, 1865. Laversine, Paris Basin, Eocene of France; length 11.0mm, width 3.5mm (from Deshayes, 1865, Atlas, pl. 104, figs. 1, 2). Type species of *Volvariella* Fischer, 1883.

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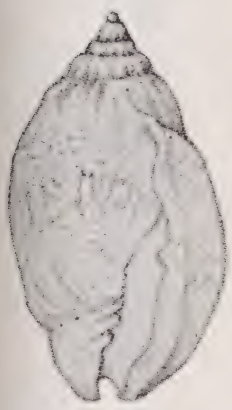

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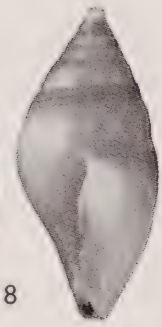

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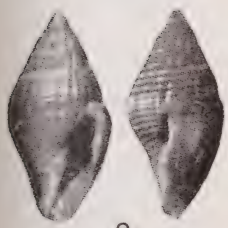

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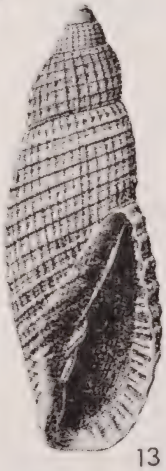

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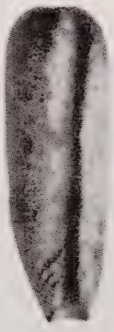

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III. FAMILY VOLUTOMITRIDAE

The first species of *Volutomitra* was brought to the attention of naturalists through the description of *Mitra groenlandica* Beck in Möller, 1842, from the Arctic sea of Greenland. Because of its mitrid appearance, the species was retained in the genus *Mitra* by Reeve (1844-45). H. & A. Adams (1853) proposed the genus *Volutomitra* in the family Mitridae, but apart from *Volutomitra groenlandica*, all other included species were true mitrids. Gray proposed the subfamily Volutomitrinae and in 1857 he transferred the group to the Volutidae on the basis of the radula, which resembled the volutid *Scaphella turneri*. The majority of authors, i.e. Troschel (1867), Sowerby (1887), Fischer (1887), Thiele (1929) and Wenz (1943), included the Volutomitrinae in the family Volutidae. Cossmann (1899) retained *Microvoluta* Angas, in the Volutidae, remarking that the genus is intermediate between the *Voluta* and *Mitra*, but eliminated *Volutomitra* from the Volutidae because of the mitrid appearance of the species. Pilsbry & Olsson (1954) also retained the Volutomitrinae in the Volutidae, stating that Volutomitrinae lack an operculum and added the New Zealand Tertiary *Parvimitra* Finlay to the volutid subfamily Scaphellinae. Tryon (1882) and Cotton (1957) assigned the Volutomitrinae to the family Mitridae.

The mitrid-like shell and volutid type of radula of the Volutomitrinae prompted authors to assign the group to one family or the other, the features of the radula generally being given prime consideration in the choice of assignment. In this study it is proposed that the Volutomitrinae be elevated in rank to a family, and considered intermediate in characters between the Volutidae and Mitridae. Volutomitridae have continued as a distinct stock from Early Paleocene or Late Cretaceous times to the present day, and a common ancestor of the Volutidae, Mitridae and Volutomitridae must date back to Middle or possibly Early Cretaceous.

Iredale & McMichael (1962) were the first authors to accord familial rank to the Volutomitridae by proposing two superfluous families Peculatoriidae and Microvolutidae for volutomitrid genera. Fleming (1966) also recognized the Microvolutidae as a separate family.

The group of Austral-Neozelanic species placed hitherto in the family Mitridae, and comprising the genera *Waimatea* Finlay, *Proximitra* Finlay, and *Parvimitra* Finlay, have been re-assigned to the Volutomitridae. The Tertiary *Conomitra* Conrad, the parent stock of all volutomitrid genus groups, has also been located in the Volutomitridae. The Recent *Microvoluta* obviously descended from the Tertiary *Conomitra*, and species of both groups still retain many characters in common. *Conomitra*, however, became extinct in the European and Caribbean regions during Lower Miocene times, and persisted in the Austral-Neozelanic region to middle and late Miocene times. Recent species survive in the Caribbean, South Africa, Philippines and the Austral-Neozelanic province, and all Recent species have been assigned to *Microvoluta*. *Volutomitra* appears to be a Pliocene offshoot of *Waimatea*, and the Recent Austral-Neozelanic *Peculator* is a small remnant group of the Miocene *Parvimitra*. *Proximitra* can be traced back to the Paris Basin Eocene, where one species, *P.genotiaeformis* (Cossmann), can be referred to the genus with certainty. *Proximitra* made an appearance in New Zealand during the Late Oligocene and became extinct during the Middle Miocene; *Conomitra apalachee* Gardner, a species closely resembling a *Proximitra*, is the only Lower Miocene record from Florida. *Parvimitra* is a Miocene offshoot of the Austral-Neozelanic *Proximitra* stock. The hypothetical phylogeny is shown in Fig. 183.

Contrary to Pilsbry & Olsson's (1954) statement that Volutomitridae are not operculate, we have found opercula in the genera *Volutomitra*, *Paradmete* and *Waimatea*, while Verco (1896) and Cotton (1957) figured the operculum of *Peculator*. The presence of an operculum in Volutomitridae dissociates the group from the non-operculate Mitridae which do have an operculum only in the veliger stage, similarly to the taenioglossate Cypraeidae.

Volutomitrid radulae, penes, operculum and head are shown in Figs. 184 - 189, protoconchs in Figs. 190 - 212.

The present proposed classification may require future modifications following more advanced knowledge of the anatomy and radula, together with a clearer understanding of the group's geographic dispersal combining future discoveries of deep-water species in new faunal regions. The present arrangement may appear to favour overdivision, considering the sometimes striking similarity of shell

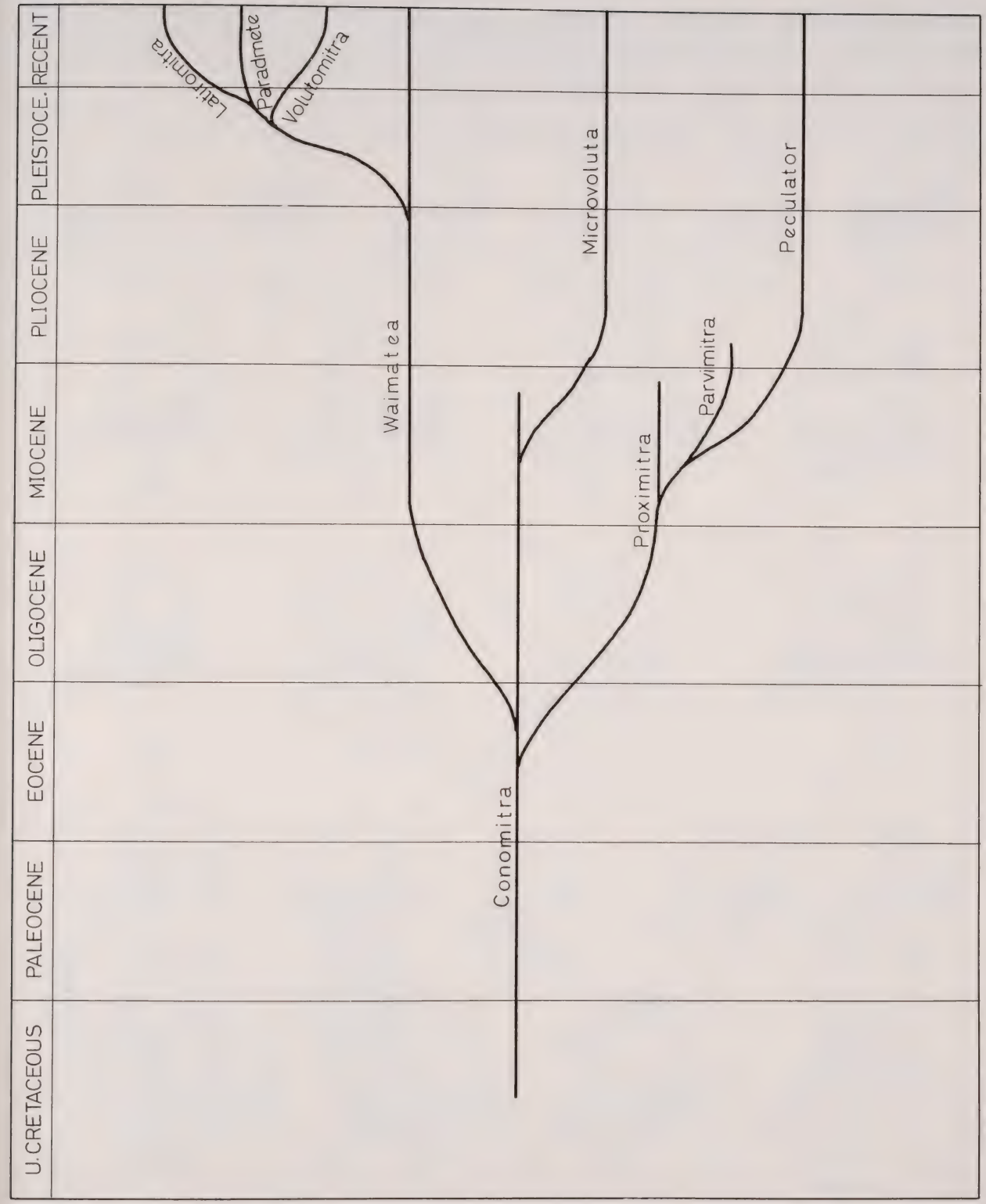

Fig. 183. Hypothetical phylogeny of the family Volutomitridae.

characters of Tertiary *Conomitra* and Recent *Microvoluta* species. Only a thorough revision of all known *Conomitra* species and comparison of results with species of the genera *Waimatea, Proximitra, Parvimitra,* and in particular *Microvoluta,* may shed some light on existing relationships within these groups and possibly confirm the presence of other natural groups within the family. It is assumed

that the presence of a *Proximitra* species in the Paris Basin Eocene and Florida Miocene is not accidental, nor a case of parallel development, but rather a reflection of the close relationship of the *Proximitra* group to *Conomitra*. On shell characters alone, some Eocene, Oligocene and Lower Miocene *Conomitra* species could equally well be placed in *Microvoluta*. Species of both groups produce slender and broad individuals and plicate and smooth forms (see *Microvoluta joloensis*) and a separation of smooth and plicate species in different generic groups would be taxonomically unsound.

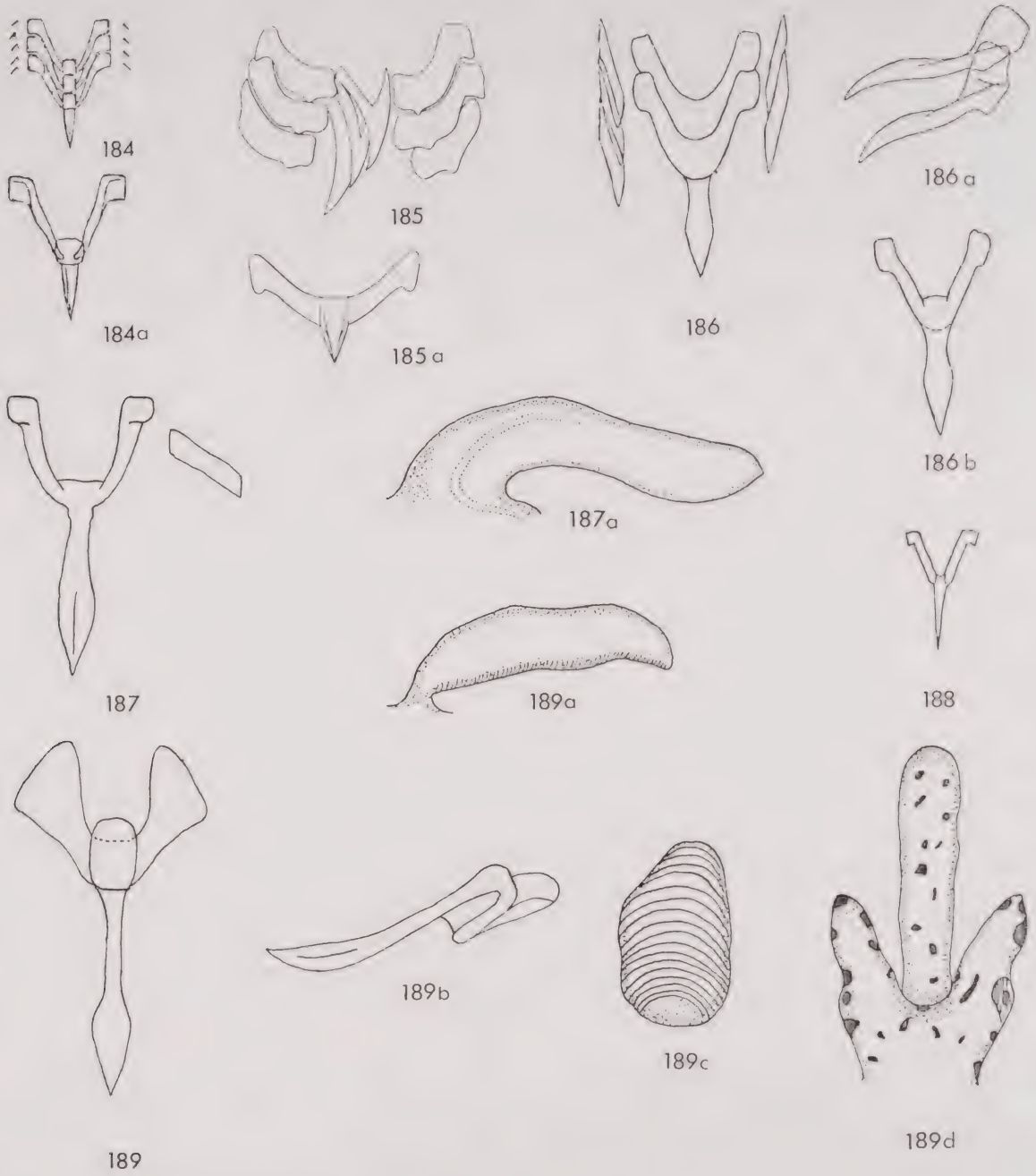

Fig. 184. *Volutomitra(Volutomitra)groenlandica* (Beck in Möller). Three rows of teeth. Fig. 184a. Rachidian (after Sars, 1878, pl. 9, fig. 12). Fig. 185. *V.(V.)groenlandica* (Beck in Möller). Three rows of teeth; Greenland. Fig. 185a. Rachidian (after Troschel, 1867, pl. 5, fig. 5). Fig. 186. *Volutomitra(Paradmete)fragillima* Watson. Two rows of teeth. Fig. 186a. Lateral view of rachidians. Fig. 186b. Rachidian (after Thiele, 1912, fig. 12). Fig. 187. *V.(P.)fragillima* Watson, Nth. of South Georgia, 160 metres (87 fathoms). Half a row of teeth. Fig. 187a. Penis. Fig. 188. *Microvoluta australis* Angas. Full row of teeth, Twofold Bay, N.S.W., Australia (after Peile, 1922a, fig. 8). Fig. 189. *Waimatea obscura* (Hutton). Full row of teeth, Poor Knights Islands, New Zealand, 5 - 10 fathoms (9 - 18 metres). Fig. 189a. Penis. Fig. 189b. Latero-ventral view of rachidian. Fig. 189c. Operculum. Fig. 189d. Head and extended proboscis of animal of *W.obscura*.

The majority of Recent Volutomitridae live in moderately deep water, at water temperatures ranging from 30° to 50°F (−1° to +10°C). In tropical and subtropical regions, species have to go deep in order to reach the corresponding low water temperatures.

Protoconchs of Volutomitridae. Figs. 190 & 191. *Volutomitra(Paradmete)fragillima* Watson (from same locality). Figs. 192 & 193. *Waimatea inconspicua* (Hutton). Fig. 194. *W.parki* (Allan). Fig. 195. *W.obscura* (Hutton). Fig. 196. *W.othone* (Tenison-Woods). Figs. 197 & 198. *W.othone* (Tenison-Woods) (holotype and paratype of *W.othoniana* Finlay respectively). Fig. 199. *Proximitra(Proximitra)rutidoloma* (Suter). Figs. 200 & 201. *P.(P.)apicalis* (Hutton) (holotype and topotype respectively). Figs. 202 & 203. *P.(P.)atractoides atractoides* (Tate) (from Grice's Creek, Victoria and Table Cape, Tasmania, respectively). Fig. 204. *P.(P.)atractoides armorica* (Suter). Fig. 205. *Proximitra(Parvimitra)pukeuriensis* (Finlay). Figs. 206 & 207. *Conomitra plicatella* (Marshall & Murdoch). Fig. 208. *Conomitra pentaploca* (Finlay). Fig. 209. *Peculator verconis* Iredale. Fig. 210. *P.clifdenensis* (Finlay). Fig. 211. *Microvoluta australis* Angas. Fig. 212. *M.marginata* (Hutton).

LIST OF RECOGNIZED TAXA IN THE FAMILY VOLUTOMITRIDAE

(Asterisks indicate fossil species.)

Genus *Volutomitra* H. & A. Adams, 1853.

Subgenus *Volutomitra* s.str. H. & A. Adams, 1853.

groenlandica (Beck in Möller, 1842). Type. Arctic; Nth. Atlantic.
alaskana Dall, 1902. Nth. Pacific.
banksi (Dell, 1951). New Zealand.
pailoloana (J. Cate, 1963). Nth. Pacific.

Subgenus *Latiromitra* Locard, 1897.

cryptodon (Fischer, 1882). Type. N.E. Atlantic.
problematica (Ponder, 1968). New Zealand.
? *bairdii* (Dall, 1889). N.W. Atlantic.

Subgenus *Paradmete* Strebel, 1908.

fragillima Watson, 1882. Type. Antarctic; Subantarctic.
curta (Strebel, 1908). Antarctic; Subantarctic.
percarinata (Powell, 1951). Antarctic; Subantarctic.
crymochara (Rochebrune & Mabille, 1885). Subantarctic; Tierra del Fuego.

Genus *Waimatea* Finlay, 1927.

Subgenus *Waimatea* s.str. Finlay, 1927.

* *inconspicua* (Hutton, 1885). Type. Eocene: New Zealand.
* *amplexa* Finlay, 1930. Eocene: New Zealand.
* *parki* (Allan, 1926). Eocene: New Zealand.
* *incisa* (Marwick, 1942). Eocene: New Zealand.
obscura (Hutton, 1873). Australia and New Zealand.
* *conoidalis* (Tate, 1889). Miocene: Australia.
* *enavata* (Marwick, 1931). Pliocene: New Zealand.
* *costulosa* (Marwick, 1965). Pliocene: New Zealand.
* *enysi* (Hutton, 1873). Oligocene: New Zealand.
* *othone* (Tenison-Woods, 1880). Miocene: Australia and New Zealand.
* *lornensis* (Marwick, 1926). Eocene: New Zealand.

Genus *Proximitra* Finlay, 1927.

Subgenus *Proximitra* s.str. Finlay, 1927.

* *rutidoloma* (Suter, 1917). Type. Miocene: New Zealand.
* *apicalis* (Hutton, 1873). Miocene: New Zealand.
* *balteata* (Marwick, 1931). Miocene: New Zealand.
* *tumens* (Finlay, 1930). Miocene: New Zealand.
* *genotiaeformis* (Cossmann, 1896). Eocene: Europe.
* *apalachee* (Gardner, 1937). Miocene: S.E. United States.
* *atractoides* (Tate, 1889). Miocene: Australia.
* subsp. *armorica* (Suter, 1917). U. Oligocene - L. Miocene: New Zealand.

Subgenus *Parvimitra* Finlay, 1930.

* *paucinoda* (Finlay, 1930). Miocene: New Zealand.
* *pukeuriensis* (Finlay, 1930). Miocene: New Zealand.
* *clathurella* (Tate, 1889). Miocene: Australia.
* *plicifera* (Marwick, 1928). L. Pliocene: New Zealand.

Genus *Conomitra* Conrad, 1865.

Subgenus *Conomitra* s.str. Conrad, 1865.

* *fusoides* (Lea, 1833). Type. Eocene: S.E. United States.
subsp. *hammakeri* (Harris, 1894). Eocene: S.E. United States.
* ? *limburgensis* (Binkhorst, 1861). U. Cretaceous: Europe.
* ? *Conomitra sp.* (Sohl, 1964). U. Cretaceous: S.E. United States.
* *glabra* (Ravn, 1933). Paleocene: Europe.
* *wateleti* (Briart & Cornet, 1871). Paleocene: Europe.
* *prisca* (Deshayes, 1865). Paleocene: Europe.
* *berthelini* (Cossmann, 1896). Eocene: Europe.
* *conuliformis* (Cossmann, 1896). Eocene: Europe.
* *diasticta* (Cossmann, 1896). Eocene: Europe.
* *distensa* Cossmann & Pissarro, 1901. Eocene: Europe.
* *dolljusi* Cossmann & Pissarro, 1901. Eocene: Europe.
* *fusellina* (Lamarck, 1803). Eocene: Europe.
* *graniformis* (Lamarck, 1803). Eocene: Europe.
* *hemicolpodes* Cossmann & Pissarro, 1901. Eocene: Europe.
* *hemiconoides* (Cossmann, 1897). Eocene: Europe.
* *lennieri* (Cossmann & Pissarro, 1901). Eocene: Europe.
* *namnetica* (Cossmann, 1896). Eocene: Europe.
* *marginata* (Lamarck, 1803). Eocene: Europe.
* *tenuiplicata* (Vasseur, 1881). Eocene: Europe.
* *textiliosa* Cossmann & Pissarro, 1901. Eocene: Europe.
* *vincentiana* (Cossmann, 1881). Eocene: Europe.
* *parva* (J. de C. Sowerby, 1823). Eocene: England.
* *porrecta* (F. E. Edwards, 1856). Eocene: England.
* *alizalis* (Anderson & Hanna, 1925). Eocene: W. United States.
* *polita* Vaughan, 1896. Eocene: S.E. United States.
* *texana* (Harris, 1895). Eocene: S.E. United States.
* *washingtoniana* (Weaver, 1912). Eocene: N.W. United States.
* *plicatella* (Marshall & Murdoch, 1923). Eocene: New Zealand.
* *staminea* (Conrad, 1848). Oligocene: S.E. United States.
* *inornata* (Beyrich, 1854). Oligocene: Europe.
* *extensa* (Koenen, 1890). Oligocene: Europe.
* *perminuta* (Sandberger, 1863). Oligocene: Europe.
* *ravni* (Harder, 1913). Oligocene: Europe.
* *secalina* (Koenen, 1890) [nom. praeocc.]. Oligocene: Europe.
* *semimarginata* (Beyrich, 1854). Oligocene: Europe.
* *sulcifera* (Koenen, 1890). Oligocene: Europe.
* *peyreirensis* (Peyrot, 1928). L. Miocene: Europe.

* *pentaploca* (Finlay, 1927). M. Miocene: Australia.
* *wainuioruensis* (Vella, 1954). U. Miocene: New Zealand.
* + 20 *Conomitra* sp. (tentatively listed on p. 114).

Genus *Peculator* Iredale, 1924.
Subgenus *Peculator* s.str. Iredale, 1924.
verconis Iredale, 1924. Type. S.E. Australia.
porphyria (Verco, 1896). Australia and New Zealand.
hedleyi (Murdoch, 1905). New Zealand.
obconicus (Powell, 1952). New Zealand.
* *cassida* (Tate, 1889). Miocene - Pliocene: Australia.
* *clifdenensis* (Finlay, 1930). Miocene: New Zealand.

Genus *Microvoluta* Angas, 1877.
Subgenus *Microvoluta* s.str. Angas, 1877.
australis Angas, 1877. Type. S.E. Australia.
* *complanata* (Tate, 1889). Pliocene: Australia.
* *atypha* (Tate, 1889). Pliocene: Australia.
* *subcrenularis* (Tate, 1889). Pliocene: Australia.
royana Iredale, 1924. Australia.
marginata (Hutton, 1885). Pleistocene - Recent: New Zealand.
* *vetusta* Laws, 1936. Pliocene: New Zealand.
teretiuscula (Thiele, 1925). South Africa.
hottentota (Thiele, 1925). South Africa.
joloensis Cernohorsky, 1970. Philippines.
intermedia (Dall, 1890). Caribbean.
blakeana (Dall, 1889). Caribbean.

SYSTEMATICS

Superfamily VOLUTACEA Fleming, 1822

Family VOLUTOMITRIDAE Gray, 1854 (nom. transl.)

1854. Volutomitrina Gray, Proc. Zool. Soc. Lond., pt. 21: 36.
1907. Volutomitrinae Dall, Smiths. Misc. Coll., 48 (3): 372.
1962. Microvolutidae Iredale & McMichael, Mem. Austral. Mus., 11: 62.
1962. Peculatoridae Iredale & McMichael, Mem. Austral. Mus., 11: 64.

Shell very small to moderate in size, 4 - 47mm, fusiform, ovate, cylindrical or biconic, moderately thin and fragile, spire high or low; teleoconch with 3 - 8 flat-sided, convex or concave whorls, protoconch with 1 - 3 (generally 1½ - 2) smooth, bulbous, globose or dome shaped nuclear whorls. Smooth, or sculptured with axial ribs, spiral striae, growth lines or peripheral nodules, and frequently with an impressed sutural girdle. Aperture wide or narrow, shorter or longer than the spire, smooth or lirate within; labial lip thin or thickened, simple, angulate, or crescent shaped. Columella with 2 - 5 folds, folds often distant and irregular and not sloping in the same direction, first posterior fold generally shorter than the second fold. Siphonal canal straight or recurved towards the aperture, short or moderately long, siphonal notch very feeble or mostly absent. Periostracum thin, opaque or translucent, brown or yellow in colour.

The animal is variously coloured, often spotted or marbled; the head is short and broad, tentacles moderately short and stubby, eyes small or large, round or elliptical and situated on the sides of the thickened base of tentacles; siphon moderately short. The penis is claviform and smooth.

The operculum is small, *c.* 2 - 6mm in length, slender and elongate or irregularly ovate, brown in colour, rather thin, nucleus indistinct. Radular formula is 1-1-1 or 0-1-0, odontophore translucent white, very small and narrow, *c.* 5 - 7% of shell length. Radular pattern is similar to the volutid genus *Scaphella,* rachidians are wishbone-shaped and equipped with a moderately long or short, simple and curved cusp. Laterals, whenever present, are very thin, simple, rhomboidal and cuspless; the ribbon numbers *c.* 150 - 300 rows of teeth.

In this study, species of Volutomitridae have been arranged in 6 genera and 3 subgenera, exclusive of nominate subgenera. A total of 88 (?108) species and 2 subspecies have been recorded, of which 66 (?86) taxa are fossil and 24 Recent.

Habitat: In mud and sand, from 10 - 1,900 metres (5 - 1,040 fathoms), at water temperatures ranging from −1°C to +12°C (30° - 53°F). Only one species occurs intertidally at temperatures up to 20°C (68°F) in Austral-Neozelanic waters.

Geographical distribution: Arctic and Subarctic; Caribbean; Nth. Pacific; Sth. Africa; Nth. Atlantic; Philippines; Austral-Neozelanic region; Antarctic and Subantarctic.

Stratigraphical range: Upper Cretaceous — Recent.

Genus Volutomitra H. & A. Adams, 1853

Volutomitra H. & A. Adams, 1853, Gen. Rec. Moll., 1: 172. Type species by SD (Fischer, 1884) *V.groenlandica* Beck = *Mitra groenlandica* Beck in Möller, 1842. Recent, Arctic Sea.

= 1857. *Volutimitra* Gray, Guide Syst. Distr. Moll. Brit. Mus., p. 36 (nom. null.).
= 1892. *Volutamitra* Standen & Roebuck, J. Conch., 7: 125 (nom. null.).
= 1925. *Volumitra* Coates, Trans. Proc. Perthshire Soc. nat. Sci., 8: 53 (nom. null.).

Shell small to moderate in size, 10 - 47mm, fusiformly elongate to fusiformly ovate, generally white in colour under a dark brown periostracum; teleoconch of 5 - 6 convex whorls, protoconch of 1½ - 2 obtuse, smooth nuclear whorls. Smooth in appearance, sculptured with fine spiral striae, axial growth striae and occasionally obsolete axial costae. Aperture about equal in height or longer than the spire, porcellaneous white or brown, smooth within; labial lip simple, crescent shaped or slightly angulate and narrowing towards the base. Columella calloused, callus shield extending on to body whorl, and with 3 - 5 distant folds; the folds either weak or moderately strong, the first posterior folds smaller than the second fold, and weakly indicated or absent in juvenile specimens. Siphonal canal straight or slightly recurved, short or produced, siphonal notch absent. The presence of an operculum has been confirmed in *V.alaskana.*

The radular formula is 1-1-1, rachidians are wishbone shaped with a single curved central cusp, laterals are small, thin, rhomboidal and often lost during extraction (Figs. 184-185). The genus contains 4 living species.

GEOGRAPHICAL DISTRIBUTION: Arctic and Subarctic; Nth. Atlantic; Nth. Pacific; New Zealand. Lat. 20° - 80°N and Lat. 43° - 44°S.

STRATIGRAPHICAL RANGE: Pliocene—Recent.

HABITAT: In mud and sand, from 27 - 1,500 metres (14 - 822 fathoms).

Volutomitra groenlandica (Beck in Möller, 1842)

(Plate 13, fig. 1)

1842. *Mitra groenlandica* Beck in Möller, Naturhist. Tidsskrift, 4 (1): 88.
1844. *Mitra groenlandica* "Gray MS", Reeve, Conch. Icon., pl. 15, sp. 106.
1853. *Mitra groenlandica* Gray, Ann. Mag. Nat. Hist., 12: 129 (radula).
1867. *Volutomitra groenlandica* "Gray", Troschel, Geb. Schnecken, 2: 56, pl. 5, figs. 5a, b (radula).
1874. *Mitra graenlandica* (sic) Gray, Sowerby, Thes. Conch., 4: 25, pl. 23, fig. 519.
1878. *Volutomitra groenlandica* Beck, Sars, Moll. reg. Arct. Norveg., 1: pl. 9, figs. 12a, b, c (radula).
1889. *Volutomitra groenlandica* Beck, Dall, Bull. Mus. Comp. Zool. Harvard, 18: 145, pl. 34, figs. 7a, b.
1889. *Volutomitra groenlandica* Beck, Dall, Bull. U.S. Nat. Mus., No. 37: 187, pl. 34, figs. 6, 7 (shell & radula).

TYPE LOCALITY: Greenland.

DISTRIBUTION: From the Parry Islands, N.W. Territory of Canada, to Greenland, Spitsbergen, Norway, Faroe Islds., Iceland and south-westward to Cape Cod, east coast of the United States. Not recorded south of Lat. 40°N.

HABITAT: In mud, sand and shale, from 27 - 500 metres (15 - 280 fathoms).

Shell moderately small, 10 - 30mm, fusiformly ovate, width 40 - 48% of length; white in colour, covered by a dark brown periostracum. Teleoconch of 5 - 5½ convex whorls, protoconch of 1½ - 2 bluntly rounded, smooth nuclear whorls. Sculptured with numerous and fine spiral striae which may be either prominent or obsolete, longitudinal growth striae and occasionally axial costae on early whorls. Aperture moderately wide, equal in height or longer than the spire, 54 - 61% of length, smooth within; labial lip thin and simple, columella generally with 4 folds, posterior fold the smallest. A callus shield is vision the columella in adult specimens.

The radula consists of wishbone-shaped rachidians and rhomboidal laterals which are cuspless. The laterals are thin and fragile, and are easily lost in a hot solution of caustic soda.

The probable syntypes of *Volutomitra groenlandica* are in the British Museum (Nat. Hist.) No. 43.6.30.185-189, ex Möller from Greenland. The five syntypes measure 21.0mm, 19.9mm, 18.9mm, 17.4mm and 12.2mm; the second smallest specimen has 32 spiral striae on the body whorl and 15 on the penultimate whorl.

Volutomitra alaskana Dall, 1902

(Plate 13, figs. 2 - 5)

1902. *Volutomitra alaskana* Dall, Nautilus, 15 (9): 102.
1921. *Volutomitra alaskana* Dall, Bull. U.S. Nat. Mus., No. 112: 87, pl. 11, fig. 3.
1927. *Volutomitra alaskana* Dall, Oldroyd, Mar. shells west coast Nth. Amer., 2 (1): 173.
1962. *Volutomitra alaskana* Dall, Habe, Col. Illust. shells Japan, 2: 71, pl. 35, fig. 9.

TYPE LOCALITY: In the southern and eastern part of the Bering Sea and the Aleutians, in 60 - 85 fathoms (110 - 156 metres), muddy bottom. (Holotype locality: NW of Unimak, Bering Sea, in 85 fathoms (156 metres) at 38.6°F (4°C), U.S. Fisheries Commission).

DISTRIBUTION: From the Bering Sea southwestward to Hondo, Uraga Strait, Japan, and southeastward to off San Diego, west coast of the United States. Not recorded south of Lat. 32° 30′ N.

HABITAT: In mud and sand, from 40 - 822 fathoms (73 - 1504 metres), at temperatures ranging from 30° - 44°F (−1°C to +7°C).

This species is very similar to *V.groenlandica*. Shells are variable in colour, ranging from a yellow to brown, generally larger, 22 - 47mm in length, and the interior of the aperture is porcellaneous white and not brown or brownish-grey as in *V.groenlandica*. Some individuals of *V.groenlandica* are as finely sculptured as specimens of *V.alaskana*.

Volutomitra alaskana is operculate; the operculum measures *c.* 6.3 x 4.7mm, and is irregularly ovate, thin, light brown in colour and lacks a distinct nucleus. On the obverse side of the operculum is a hard and horny, elevated, horseshoe-shaped callosity. Newly hatched veligers are *c.* 3mm in length, and consist of $2\frac{1}{2}$ whorls; the body whorl is spirally striate, but earlier whorls are smooth; the columella already has 2 - 3 folds, whereas in adults the number of columellar plaits varies from 3 - 5.

TABLE 3

DISTRIBUTIONAL TABLE FOR VOLUTOMITRA ALASKANA DALL, SHOWING CORRELATION OF BOTTOM TEMPERATURES, LATITUDE AND DEPTH

LOCALITY	Water depth in fathoms (metres in parentheses)	Temperature at sea bottom in F (in parentheses in C)	North Latitude
Off Pribilof Islands, Bering Sea	106 (194)	37.3° (3°)	57°
ditto	74 (135)	37.9° (3°)	57°
Off Unalaska, Aleutian Islands	78 (143)	40.1° (4.5°)	54°
NW off Unimak, Bering Sea	85 (156)	38.6° (4°)	54°
Bomasiri Shima, Japan	325 (595)	34.0° (1°)	52°
Gulf of Tartary (= Tartar Strait)	42 (77)	30.7° (—1°)	51°
Benkei Mizaki, Japan	406 (743)	32.7° (0°)	43°
ditto	428 (783)	32.7° (0°)	43°
ditto	284 (520)	33.0° (0.5°)	43°
Near Hakodate, Japan	266 (487)	37.9° (3°)	42°
Tsugaru Str., coast of Jesso, Japan	300 (549)	34.9° (2°)	$41\frac{1}{2}$°
Off Sado Island, Japan	200 (366)	33.9° (1°)	38°
Uraga Str., off Hondo, Japan	302 (553)	43.9° (6.5°)	35°
Off San Diego, California	822 (1504)	39.0° (4°)	$32\frac{1}{2}$°

The holotype of *V.alaskana* is in the United States National Museum, No. USNM 122586; the dimensions are length 43.0mm, width 18.0mm, height of aperture 25.0mm. Oldroyd's (1927) type locality designation of "Pribilof Islands" is void, since the holotype had been collected at NW-Unimak, in the Bering Sea.

Table 3 shows the distribution and correlation of depth and latitude of *V.alaskana*.

Volutomitra banksi (Dell, 1951)

(Plate 13, fig. 6)

1951. *Proximitra banksi* Dell, Rec. Canterbury Mus., 6 (1): 54, pl. 1, fig. 7.
1956. *Proximitra banksi* Dell, Bull. Dom. Mus., Wellington, 18: 88, fig. 170.
1967. *Proximitra banksi* Dell, Beu, Trans. Roy. Soc. N.Z. Geol., 5 (3): 110, pl. 2, fig. 16.

TYPE LOCALITY: Off Banks Peninsula (New Zealand), in 80 fathoms (146 metres).

DISTRIBUTION: Off Banks Peninsula to Chatham Islands; east of Whangaimoana, Palliser Bay, in Upper Pliocene (Waitotaran) deposits.

HABITAT: Dredged at depth from 80 - 320 fathoms (146 - 586 metres).

Shell moderate in size, 27 - 43mm, fusiformly ovate, somewhat inflated, covered with a light olive-brown periostracum; teleoconch of *c.* 5 convex whorls, protoconch of 2 bulbous and smooth nuclear whorls. Early whorls axially costate, later whorls smooth and sculptured with fine, irregular spiral striae and axial growth lines. Aperture moderately wide, smooth within, white in colour, columella with 3 - 4 folds; the first posterior fold the smallest and set fairly high on the parietal wall. As in *V.alaskana,* the columellar callus extends on to the body whorl.

Volutomitra banksi is rather similar to the North Pacific *V.alaskana,* and one would expect to find an operculum in *V.banksi* when living material is examined.

The holotype and 2 paratypes are in the Canterbury Museum, Christchurch. Originally described from very worn and imperfect specimens, Dell (1956) published a supplemental description and figure, based on live-taken specimens from the Chatham Rise.

Volutomitra pailoloana (J. Cate, 1963)

(Plate 13, fig. 7)

1956. *Mitra languida* "Dall MS.", Bryan, Hawaiian Shell News, 4 (4): 39 (nom. nud.).
1956. *Mitra pailoloana* "Dall MS.", Bryan, Hawaiian Shell News, 4 (4): 39 (nom. nud.).
1963. *Vexillum pailoloanum* J. Cate, Veliger, 6 (1): 29, pl. 6, figs. 11 - 13.

TYPE LOCALITY: Pailolo Channel, between Maui and Molokai, Hawaiian Islands, 256 - 283 fathoms (468 - 518 metres).

DISTRIBUTION: Sth. coast of Molokai Island, 259 - 266 fathoms (474 - 487 metres); SW. coast of Oahu Island, 352 - 357 fathoms (644 - 653 metres); Sth. coast of Oahu Island, 294 - 330 fathoms (538 - 604 metres).

Shell moderately small, 15 - 30mm, elongate ovate, width 37 - 42% of length; fawn in colour, covered with a brown, opaque periostracum. Teleoconch of *c.* 6 slightly convex whorls, protoconch missing in specimens examined. Sculptured with irregular, thin axial ribs which tend to become obsolete on the body whorl, but generally number from 9 - 15 on the last whorl and from 16 - 20 on the penultimate whorl. Distinct spiral threads, *c.* 5 - 10 on the penultimate and 20 - 26 on the body whorl override axial ribs and become more prominent towards the base. Aperture about equal in height or slightly longer than the spire, 47 - 55% of total length, porcellaneous white and smooth within; labial lip simple, contracted anteriorly in some specimens, columella with 3 weak or strong folds. Siphonal canal moderately short or slightly attenuated, siphonal notch only feebly developed.

The species has all the aspects of a *Volutomitra,* and lacks the characteristic lirate labrum and siphonal notch of vexilline mitrids; the protoconch is unfortunately missing in all known specimens and placement of the species in *Volutomitra* s.str. is only tentative.

The author in her original description, placed the manuscript name "*Mitra languida* Dall" in the synonymy of the newly created *Vexillum pailoloanum.* Dall's taxon is an unavailable manuscript and nude name, which can have no type nor be synonymized with a validly established species.

The holotype of *Volutomitra pailoloana* is in the U.S. National Museum No. 173008; the dimensions are length 18.0mm, width 7.0mm, height of aperture 10.0mm.

SUBGENUS Latiromitra Locard, 1897 (of *Volutomitra*)

Latiromitra Locard, 1897, Exp. Scient. Trav. Talisman, 1: 321. Type species by M *L.specialis* Locard, 1897 = *Mitra cryptodon* Fischer, 1882. Recent, N.E. Atlantic.

= 1968. *Latriomitra* Ponder, Rec. Dom. Mus., Wellington, 6 (4): 45 (nom. null.)

Shell similar in outline to *Volutomitra* s.str., moderately small *c.* 30 - 35mm, uniformly brown in colour; teleoconch of 7 - 8 adult convex whorls, protoconch of 2 small, obtuse and globose nuclear whorls. Shell finely spirally striate, also sculptured with slender or coarse axial ribs; whorls regularly convex or slightly angulate, sutures may have an impressed sutural girdle. Aperture wide, smooth within, labial lip thin and simple, joining siphonal canal in a wide convex sweep without producing a distinct siphonal notch. Columella calloused, callus extending on to body whorl in adult specimens, and equipped with 3 - 4 thin and distant columellar folds; the first posterior fold the smallest, weakly formed or absent in immature specimens. The soft parts and operculum unknown.

Locard (1897) originally located *Latiromitra* in the family Pisaniidae (= Buccinidae), due to apparent affinities with *Latirus* and *Mitra.* Thiele (1929) and Wenz (1943) assigned *Latiromitra* to the subfamily Vexillinae in the family Mitridae. Apertural features, absence of labral lirae and siphonal notch and a globose and mamillate protoconch are features more compatible with the Volutomitridae.

GEOGRAPHICAL DISTRIBUTION: North-eastern Atlantic; New Zealand. Lat. 32°N and Lat 46°S.

STRATIGRAPHICAL RANGE: Recent.

HABITAT: Deep water, in 119 - 1900 metres (65 - 1040 fathoms).

The subgenus contains only 3 living species. *Volutomitra bairdii* (Dall, 1889), has been tentatively assigned to *Latiromitra,* pending collection of fresh material.

Volutomitra (*Latiromitra*) *cryptodon* (Fischer, 1882)

(Plate 13, fig. 9)

1882. *Mitra cryptodon* Fischer, J. Conchyl., 30: 273.

1897. *Latiromitra specialis* Locard, Exp. Scient. Trav. Talisman, 1: 321, pl. 14, figs. 30 - 34.

TYPE LOCALITY: Atlantic, in 1900 metres (*cryptodon*); Dragage 40 (1882), west of Morocco, in 1900 metres (*specialis*).

Shell moderately small, 31mm in length, fusiformly elongate, reddish-brown in colour; teleoconch of 7 - 8 convex whorls, protoconch of 2 small, obtuse and mamillate nuclear whorls. Sculptured with 17 - 18 slender axial ribs on the body whorl and numerous fine spiral striae; sutures linear and distinct, vaguely undulate and with a cingulate sutural girdle. Aperture about equal in height to the spire, moderately wide, smooth and light reddish-yellow within; labial lip thin and simple, descending to the canal in a broad convex sweep without forming a siphonal notch. Columella calloused, sculptured with 3 thin and distant folds. Type juvenile, the uppermost posterior fold not developed.

Locard (1897) overlooked Fischer's (1882) prior description of some of the Travailleur & Talisman molluscan material, and particularly the description of *Mitra cryptodon* from the same locality

and based on the same specimen. Fischer (*loc. cit.*) gave the dimensions of the type as length 31.0 mm, width 10.0mm, height of aperture 15.0mm. Locard's measurements of the type were length 30.0mm, width 10.0mm. The hotolype of *Volutomitra (Latiromitra) cryptodon* is in the Muséum National d' Histoire Naturelle in Paris.

Volutomitra (Latiromitra) problematica (Ponder, 1968)

(Plate 13, fig. 8)

1968. *Vexillum (Latriomitra ?) problematicum* Ponder, Rec. Dom. Mus., Wellington, 6 (4): 45, pl. 4, figs. 55, 56.

TYPE LOCALITY: Portobello Marine Biological Station MU-66-59, east or Taiaroa Heads, 45°50'S and 170°57'E, in 65 fathoms (119 metres).

DISTRIBUTION: Known only from the type locality.

Shell moderately small, 33mm in length, orange-brown in colour with axial ribs faded white: teleoconch of 7 slightly angulate whorls, protoconch with a remnant of ½ a nuclear whorl. Sculptured with 10 coarse axial ribs on the body whorl and 9 on the penultimate whorl: distinct spiral threads encircling the shell, overriding the axial ribs and numbering *c.* 14 on the penultimate whorl and *c.* 40 on the body whorl. Aperture wide, only slightly longer than the spire, smooth within: labial lip thin and worn, columella with 4 folds, first posterior fold very small and just forming; the labial lip joining the canal in a wide convex sweep without forming a siphonal notch. Siphonal canal slightly recurved to the left.

Ponder's (1968) placement of the New Zealand species in the subgenus *Latiromitra* appears to be appropriate. *Latiromitra problematica*, however, is a volutomitrid and bears no relationship with the mitrid Vexillinae.

The holotype of *Volutomitra (Latiromitra) problematica* is No. M-21553 in the Dominion Museum, Wellington. The type is a worn and faded immature specimen: the dimensions are length 33.1mm, width 12.9mm; height of aperture 18.2mm.

SUBGENUS Paradmete Strebel, 1908 (of *Volutomitra*)

Paradmete Strebel, 1908, Wiss. Ergeb. Schwed. Südpol. Exped., 6 (1): 22. Type species by SD (Powell, 1951) *Paradmete typica* Strebel, 1908 = *Volutomitra fragillima* Watson, 1882. Recent, Antarctic & Subantarctic.

Shell moderately small, 6 - 25mm, ventricose ovate or fusiformly elongate, thin and inflated, white or cream in colour under a yellow or light brown periostracum; teleoconch of 3 - 4½ convex or subangulate whorls, protoconch of 1½ - 2 large and bulbous nuclear whorls. Sculptured with growth striae, irregular axial riblets and fine numerous spiral striae. Aperture wide or narrow, equal in height or longer than the spire, smooth within; labial lip thin, crescent-shaped or angulate and simple. Columella thinly calloused, weak callus pad extending on to body whorl; columella with 2 - 4 irregular folds, first posterior fold smaller than the second fold and often absent in juvenile specimens. Siphonal canal open, straight or slightly recurved, siphonal notch absent. An operculum is present.

The radula (Figs. 186 - 187) is similar to the radula of *Volutomitra groenlandica*. The subgenus contains 4 Recent species.

GEOGRAPHICAL DISTRIBUTION: Antarctic and Subantarctic seas. From Lat. 50° S to Lat. 70° S.

STRATIGRAPHICAL RANGE: Recent.

HABITAT: in mud, gravel and sand, from 51 - 811 metres (28 - 443 fathoms).

Volutomitra (Paradmete) fragillima Watson, 1882

(Plate 13, fig. 10)

1882. *Volutomitra fragillima* Watson, J. Linn. Soc. Lond., 16 (93): 335.

1886. *Volutomitra fragillima* Watson, Zool. Challenger Exp., 15 (42): 263, pl. 14, fig. 7.

1908. *Paradmete typica* Strebel, Wiss. Ergeb. Schwed. Südp. Exped., 6 (1): 22, pl. 3, figs. 35a-f.

1912. *Paradmete typica* Strebel, Thiele, Deut. Südp. Exped., 13 (5): 248, figs. 12a-c (radula).
1912. *Paradmete typica* Strebel, Melvill & Standen, Trans. Roy. Soc. Edinburgh, 48: 357.
1915. *Volutomitra fragillima* Watson, E. A. Smith, Brit. Antarct. Exped., 2 (4): 74.
1951. *Paradmete fragillima* (Watson), Powell, Disc. Repts., 26: 165.

TYPE LOCALITY: Royal Sound, Kerguelen I., Lat. 49° 28′ S and Long. 70° 13′ E, in mud, 28 fathoms (51 metres) (*fragillima*). Cumberland Bay, Sth. Georgia, in 75 metres (41 fathoms) (*typica*).

DISTRIBUTION: Off Enderby Land, 193 - 300 metres (106 - 164 fathoms); off Kemp Land, 603 metres (330 fathoms); off Kaiser Wilhelm Land, 393 metres (215 fathoms); off Oates Land, 180 - 200 fathoms (329 - 366 metres); Bismarck Strait, Palmer Archipelago, 315 metres (172 fathoms); Burdwood Bank, Falkland Islds., 56 fathoms (102 metres); West Cumberland Bay, Sth. Georgia I., 110 metres (60 fathoms); Stromness Harbour to Larsen Point, Sth. Georgia I., 122 - 136 metres (67 - 74 fathoms); Nth. of Sth. Georgia I., 160 - 236 metres (87 - 128 fathoms).

Shell moderately small, 6 - 24mm, elongate ovate to ventricose ovate, width 47 - 53% of length; thin and fragile, generally white in colour, covered by a thin and yellowish periostracum. Teleoconch of 3 - 5 convex or slightly angulate whorls, protoconch of 1½ - 2 globose, smooth nuclear whorls. Sculptured with irregular, thin and sometimes obsolete axial threads which number from 12 - 20 on the body whorl and from 14 - 22 on the penultimate whorl; some axial threads more elevated than others. Numerous, fine spiral striae encircling the shell, and numbering from 15 - 20 on the penultimate whorl and from 40 - 50 on the body whorl. Aperture longer than the spire, 57 - 68% of length, wide and open, smooth within; labial lip thin and simple. Columella white, sculptured with 3 - 4 (rarely 2) distant folds, the first posterior fold being the smallest; 16 specimens examined, 8 with 4 columellar folds, 7 with 3 folds, 1 with two folds.

The animal has short and stubby tentacles and moderately large, blackish-brown, round eyes; the penis is smooth and *c.* 7.0mm long. The operculum is very small, irregularly oval, dark brown in colour and *c.* 2.0mm x 1.4mm in a shell 23.3mm long.

The radula (Fig. 187), extracted from a South Georgia specimen, agrees in all essential features with the radula of *Volutomitra (Paradmete) typica* as figured by Thiele (1912). The radula is very small, translucent white, 1.6mm long and 0.06mm wide in a shell 23.3mm long; there are 153 rows of teeth + 6 nascentes. The rachidians are wishbone-shaped, with a single, large curved cusp, and the laterals are elongate rhomboidal, simple and thin.

The holotype of *V.fragillima* is in the British Museum (Nat. Hist.); the given dimensions are length 0.57 inches (= 14.5mm), width 0.3 inches (= 7.6mm); height of aperture 0.39 inches (= 9.9mm). The types of *Paradmete typica* were presumably in the Hamburg Museum, Germany, and were destroyed during world war II; the dimensions of the 7 syntypes ranged from 15.0mm - 22.6mm in length, and from 7.3 - 10.8mm in width.

Volutomitra (Paradmete) curta (Strebel, 1908)

(Plate 13, figs. 11 - 13)

1908. *Paradmete curta* Strebel, Wiss. Ergeb. Schwed. Südp. Exped., 6 (1): 22, pl. 3, figs. 34a-e.
1908. *Paradmete longicauda* Strebel, Wiss. Ergeb. Schwed. Südp. Exped., 6 (1): 24, pl. 3, figs. 36a-b.
1951. *Paradmete longicauda* Strebel, Powell, Discov. Repts., 26: 165.
1958. *Paradmete curta* Strebel, Powell, B.A.N.Z. Ant. Res. Exped., 6 (9): 198.

TYPE LOCALITY: Off Shag Rock Bank, Tierra del Fuego, Lat. 53° 34′ S and Long. 43° 23′ W, gravel and sand, in 160 metres (87 fathoms), at 2.05°C (36°F) (*curta*). Kochtopfbucht, South Georgia, Lat. 54° 22′ S and Long. 36° 27′ W, clay, in 95 metres (52 fathoms) (*longicauda*).

DISTRIBUTION: Off Mackenzie Sea, 456 metres (249 fathoms); West Cumberland Bay, South Georgia, 110 metres (60 fathoms); off Enderby Land, 193 - 300 metres (105 - 164 fathoms).

Shell moderately small, 9 - 25mm, and similar in form, proportion and protoconch to *Volutomitra (Paradmete) fragillima*. *V.(P.) curta* has angulate whorls, more prominent axial riblets and spiral striae, and generally only 2 folds on the columella, rarely 3 or 4; 14 specimens examined, 12 with 2 columellar folds, 2 with 4 folds. Strebel (1908) recorded one specimen of *V.(P.)curta* with 3 columellar folds.

Strebel (*loc. cit.*) separated *V.(P.)longicauda* from *V.(P.)curta* on features of longer aperture, light horn-coloured periostracum and more distinct sculpture, especially on the early whorls. He pointed out, however, that the 3 new species he described all possessed common diagnostic features, and when more material became available they might be found to be forms of a single species. In the 14 specimens examined, the sculpture proved to be highly variable. In some specimens, the axial ribs were unobtrusive and became obsolete toward the centre of the body whorl, while in other specimens the axial ribs were elevated and prominently angulate. The height of the aperture in relation to the height of the shell was found to vary as much as in *V.(P.)fragillima*.

Volutomitra (Paradmete) percarinata (Powell, 1951)

1951. *Paradmete percarinata* Powell, Discov. Repts., 26: 166, pl. 9, fig. 57.

1953. *Paradmete tricarinata* (sic) Powell, Carcelles, Anal. Mus. Nah. Huapí, 3: 196.

1958. *Paradmete percarinata* Powell, B.A.N.Z. Ant. Res. Exped., 6 (9): 198.

TYPE LOCALITY: Off South side of Clarence Island, 7 miles east of Cape Bowles, South Shetland Islands, in 785 - 810 metres (429 - 442 fathoms).

DISTRIBUTION: Off Enderby Land, 300 metres (164 fathoms).

Shell moderately small, *c.* 17mm in length, broadly ovate; teleoconch of 4 whorls, protoconch missing, whorls with a distinct angulate presutural ramp. Sculptured with fine spiral striae, 10 - 12 on the penultimate whorl, *c.* 45 on the body whorl; axial sculpture in form of weak and irregular growth lines. Aperture long, wide and open, labial lip thin and simple, columella with 3 folds.

The species is known by 2 dead collected shells. In general appearance, the species is intermediate between *V.(P.)fragillima* and *V.(P.)curta*; more material will have to be examined before *V.percarinata* can be confirmed as a good species.

The holotype of *V.(P.)percarinata* is in the British Museum (Nat. Hist.), London; the dimensions are length 16.5mm, width 10.5mm.

Volutomitra (Paradmete) crymochara (Rochebrune & Mabille, 1885)
(Plate 14, fig. 1)

1885. *Mitra crymochara* Rochebrune & Mabille, Bull. Soc. Phil. Paris, 9: 102.

1889. *Mitra crymochara* Rochebrune & Mabille, Miss. sci. Cap Horn, 6: 49, pl. 3, figs. 1a, b.

1947. *Mitra crymochara* Rochebrune & Mabille, Carcelles, Com. Zool. Mus. Hist. Nat. Montevideo, 2 (40): 10, fig. 6.

1951. *Mitraria chrymochara* (sic) (Rochebrune & Mabille), Carcelles & Williamson, Rev. Inst. Nac. Cienc. Nat. Mus. Argent., 2 (5): 301.

1951. *Paradmete crymochara* (Rochebrune & Mabille), Powell, Disc. Repts., 26: 166.

TYPE LOCALITY: Cape Horn, Argentina.

DISTRIBUTION: S.E. of Tierra del Fuego, 220 metres (120 fathoms); between Tierra del Fuego and Falkland Islands, Lat. 54° 26′ 30″ S and Long. 64° 53′ W, 61 fathoms (112 metres); between Cape Horn and Staten Island, 121 metres (66 fathoms); Bahía Orange; Isla de los Estados, 30 fathoms (55 metres).

Shell moderately small, 17 - 22mm, thin and slender, elongate ovate, width 36 - 41% of length; white in colour, covered with a thin, yellowish periostracum. Teleoconch of 4 - 4½ whorls, protoconch of 1½ - 2 globose nuclear whorls. Sculptured with numerous, fine and irregular spiral threads and occasionally a presutural carina. Aperture narrow and elongate, equal in height or longer than spire, 48 - 58% of total length, smooth within; labial lip thin and simple, columella with 3 - 4 folds, first posterior fold the smallest.

The holotype is in the Muséum National d'Histoire Naturelle in Paris; the dimensions are length 17.0mm, width 7.0mm. Rochebrune & Mabille's (1889) stated size of 12.0mm for the length is a *lapsus* for 17.0mm, according to the appended scale to the figure.

Genus **Conomitra** Conrad, 1865

Conomitra Conrad, 1865, Amer. J. Conch., 1 (1): 25. Type species by SD (Fischer, 1884) *Mitra fusoides* Lea, 1833. Eocene, S.E. United States.

Shell small to very small, 4 - 22mm, biconic, ovate or elongate, whorls convex or subangulate, protoconch elevated or depressed, nuclear whorls papillose, nipple-like or dome shaped. Sculptured with axial ribs and spiral striae, sculpture often obsolete, sutures with a simple or moniliform girdle. Labial lip moderately thin, simple, crescent-shaped or constricted anteriorly, labrum lirate or smooth; columella with 3 - 5 irregular, distant folds, first posterior fold generally shorter than the second fold which may at times be oriented at almost right angles to the axis of the shell. Anterior canal blunt or only slightly produced, spout-shaped, siphonal notch feeble or absent.

Species of *Conomitra* display a greater than usual amount of variation, both in form and sculpture, and individuals of a species are either broad or slender, axially ribbed or almost smooth. Ecophenotypic variation was as pronounced in Tertiary *Conomitra* species as it is in the Recent *Microvoluta*. *Conomitra* is the most ancient stock of the Volutomitridae; the group flourished during the Eocene, and persisted to the Lower Miocene in Europe and the United States and to Middle and Upper Miocene times in Australia and New Zealand. The last European records of *Conomitra* are from the Aquitanian stage, Lower Miocene, but is considered to be Upper Oligocene by some authors (Sorgenfrei, 1958). The Pliocene to Recent *Microvoluta* and Miocene to Recent *Peculator* are direct descendants of *Conomitra*. Many of the Eocene - L. Miocene *Conomitra* species, i.e. *C.graniformis* (Lamarck), *C. sulcifera* (Koenen) and *C.peyreirensis* (Peyrot), closely resemble living species of *Microvoluta*.

In this study, 40 fossil species have been assigned to *Conomitra*, and another 20 species may also possibly belong to this group. In view of the great variation within species, it is doubtful that all named forms are valid species. A critical examination of all known Tertiary *Conomitra* species will undoubtedly add several other species to the list and place some in the synonymy of previously established species.

Geographical distribution: Europe; United States; Australia; New Zealand.

Stratigraphical range: Lower Paleocene - Upper Miocene (? Upper Cretaceous - Upper Miocene).

? *Conomitra limburgensis* (Binkhorst, 1861)

1861. *Imbricaria limburgensis* Binkhorst, Mon. Gast. Ceph. Craig Limbourg, p. 16, pl. 2, figs. 8a, b (only).

type locality: Limbourg (Upper Cretaceous of Belgium).

Shell moderate in size, large for the genus, coniform, whorls flat to slightly concave below sutures. Sculptured with obsolete axial riblets near sutures, axial growth lines and spiral striae on the body whorl, bisecting axials and spirals on earlier whorls and nodules at sutures. Aperture longer than the spire, narrow, smooth within, labial lip thin and simple, parallel to body; columella with 4 thin and distant folds placed fairly high. Siphonal notch absent, anterior canal straight. Length 53.0mm, width 22.0mm.

The species bears only a superficial resemblance to the mitrid genus *Imbricaria*, and the disposition of the columellar folds and absence of a siphonal notch exclude the species from the Mitridae. The large size is rather unusual for the genus *Conomitra*, and the species could possibly be a volutid.

? *Conomitra species* (Sohl, 1964)

1964. Mitrid species Sohl, Geol. Surv. Prof. Pap., No. 331-C: 382, pl. 56, figs. 5, 6.

locality: Coffee Sand, Upper Cretaceous of Mississippi, S.E. United States.

This small, *c.* 8mm-long species, recorded but not named by Sohl (1964) from the Coffee Sand deposits of Mississippi, has the appearance of a *Conomitra*. Axial plications are visible on early whorls, the columellar folds are distant, and the first posterior fold has the appearance of being shorter and less oblique than the second fold. The somewhat longer than usual siphonal canal may be due to the specimen being immature. The species also resembles the New Zealand *Waimatea* group of Volutomitridae. The possibility cannot be ruled out, however, that this small, immature and badly preserved specimen is a juvenile of either *Paleofusimitra* or *Mesorhytis*.

Conomitra glabra (Ravn, 1933)

(Plate 14, fig. 3)

1933. *Turricula (Fusimitra) glabra* Ravn, Kun. Dansk. Vid. Selsk. Skr., 5 (2): 65. pl. 7, figs. 5a, b.

TYPE LOCALITY: Calcaire de Faxe (Danian, Lower Paleocene of Denmark).

A smooth species with a simple sutural girdle, spout-shaped siphonal canal, globose protoconch and thin, distant columellar folds. Length 10.5mm, width 3.8mm.

Conomitra glabra could be conspecific with *C.wateleti* (Briart & Cornet, 1871) from the Montian of Belgium and Thanetian of the Paris Basin.

Conomitra wateleti (Briart & Cornet, 1871)

1871. *Mitra wateleii* Briart & Cornet, Mem. Acad. Roy. Sci. Lett. Art. Belg., 36: 75, pl. 5, figs. 9a-c.

TYPE LOCALITY: Calcaire grossier de Mons (Montian, Mid-Paleocene of Belgium). Length 12.5mm, width 4.5mm.

The species is similar to *Conomitra glabra* (Ravn).

Conomitra prisca (Deshayes, 1865)

1865. *Mitra prisca* Deshayes, Anim. s. vert. Bass. Paris, 3 (2): 577, pl. 103, figs. 8 - 10.

TYPE LOCALITY: Brimont, Châlons-sur-Vesle (Thanetian, Upper Paleocene of France). Length 15.0mm, width 6.0mm.

Conomitra berthelini (Cossmann, 1896)

1896. *Mitra berthelini* Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 6: 102, pl. 9, figs. 16, 17.
1901. *Mitra berthelini* Cossmann, Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 89, pl. 10, figs. 13, 14.

TYPE LOCALITY: La Close, Loire (Eocene of France).

A conical, elongate ovate species with axial ribs, 3 columellar folds and a smooth labrum. Length 5.0mm, width 2.0mm, height of aperture 2.5mm.

Conomitra conuliformis (Cossmann, 1896)

1896. *Mitra conuliformis* "Cailliaud", Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 6: 104, pl. 9, figs. 13, 14.

TYPE LOCALITY: La Close, Loire (Eocene of France).

A large, conical, ovate and smooth species with a simple sutural girdle, a smooth labrum and 5 columellar folds. Similar to *C.fusellina* (Lamarck), but appreciably larger. Length 22.0mm, width 10.5mm, height of aperture 13.0mm.

Conomitra diasticta (Cossmann, 1896)

1896. *Mitra diasticta* Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 6: 107, pl. 8, figs. 34, 35.

TYPE LOCALITY: Bois-Gouet (Eocene of France).

An elongate ovate species with a smooth, subglobular protoconch and papillose nucleus, close-set axial ribs, spiral striae, a moniliform sutural girdle, lirate labrum and 4 columellar folds. Length 5.0 mm, width 2.0mm, height of aperture 2.5mm.

Conomitra distensa Cossmann & Pissarro, 1901

1901. *Conomitra distensa* Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 93, pl. 10, figs. 27, 28.

TYPE LOCALITY: Fresville, Cotentin (Mid-Eocene of France).

A smooth, elongate species with obsolete axial growth striae, a simple sutural girdle, a lirate labrum and 4 columellar folds. Length 10.0mm, width 4.0mm.

Conomitra dollfusi Cossmann & Pissarro, 1901

1901. *Conomitra dollfusi* Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 92, pl. 10, figs. 20, 21.

TYPE LOCALITY: Fresville, Cotentin (Mid-Eocene of France).

A coniform and ovate species, with regular axial ribs, spiral striae, canaliculate and moniliform sutures, a smooth labrum and 5 columellar folds. Length 14.0mm, width 8.0mm.

Conomitra fusellina (Lamarck, 1803)

1803. *Mitra fusellina* Lamarck, 1803, Ann. Mus. d'Hist. Nat. Paris, 2 (1): 59, no. 10.
1835. *Mitra fusellina* Lamarck, Deshayes, Desc. coq. foss. env. Paris, 2 (6): 667, pl. 89, figs. 18 - 20.
1896. *Mitra fusellina* Lamarck, Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 6: 103, pl. 9, figs. 23 - 26.
1901. *Conomitra fusellina* (Lamarck), Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 93, pl. 11, fig. 1.

TYPE LOCALITY: Grignon (Mid-Eocene of France).

The species is highly variable in sculpture and form, some specimens being broad and ovate, others more slender; the axial ribs generally persist to the penultimate whorl and become obsolete on the body whorl. The interior of the aperture is either smooth or lirate, the sutures have a simple girdle, the base is spirally striate and the columella has 5 folds. Length 4 - 5mm. The species has been recorded from the Lutetian - Bartonian.

Conomitra graniformis (Lamarck, 1803)

1803. *Mitra graniformis* Lamarck, Ann. Mus. d'Hist. Nat. Paris, 2 (1): 59, no. 11.
1835. *Mitra graniformis* Lamarck, Deshayes, Desc. coq. foss. env. Paris, 2 (6): 670, pl. 89, figs. 11 - 13.
1901. *Conomitra graniformis* (Lamarck), Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 92, pl. 10, fig. 24.

TYPE LOCALITY: Parnes, près Magny, Paris Basin (Mid-Eocene of France).

An elongate ovate, shining species, sculptured with very fine axials and obsolete spiral striae and a moniliform sutural girdle; labrum lirate, columella with 5 - 6 folds. Length 4 - 5mm.

Conomitra hemicolpodes Cossmann & Pissarro, 1901

1901. *Conomitra hemicolpodes* Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 94, pl. 11, figs. 5, 6.

TYPE LOCALITY: Fresville, Cotentin (Mid-Eocene of France).

An elongate ovate, ventricose species with convex whorls, crude and somewhat nodulose axial ribs and obsolete spiral striae; sutural girdle is simple, labrum smooth, columella with 4 folds. Length 6.5 mm, width 2.5mm.

Conomitra hemiconoides (Cossmann, 1897)

1897. *Turricula hemiconoides* Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 8: 217, pl. 2, figs. 15, 16.

TYPE LOCALITY: Coislin (Eocene of France).

The species bears a strong resemblance to New Zealand *Parvimitra* species. The axial ribs become nodulose on the presutural ramp and obsolete towards the base of the body whorl; 5 - 6 spiral threads cross nodules on the presutural ramp. The labrum is smooth and the columella has 4 thin and distant folds. Length 12.5mm, width 6.0mm. Cossmann's figured type appears to be immature.

Conomitra lennieri (Cossmann & Pissarro, 1901)

1901. *Mitra lennieri* Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 88, pl. 10, fig. 19.

TYPE LOCALITY: Fresville, Cotentin (Mid-Eocene of France).

A coniform, ovate species with subangulate whorls, regular and thin axial riblets and fine spiral striae; the aperture is dilated, labrum smooth, and the columella has 5 folds. This species is similar to *Conomitra berthelini* (Cossmann, 1896) from the Eocene of Loire.

Conomitra marginata (Lamarck, 1803)

(Plate 14, fig. 4)

1803. *Mitra marginata* Lamarck, Ann. Mus. d'Hist. Nat., 2 (1): 58, no. 3.
1835. *Mitra marginata* Lamarck, Deshayes, Desc. coq. foss. env. Paris, 2 (6): 669, pl. 88, figs. 13 - 14.

TYPE LOCALITY: Grignon, Paris Basin (Mid-Eocene of France). Also Bartonian, Upper Eocene of England.

A moderately small conical species, with fine axials on early whorls, a moniliform sutural girdle, a smooth or lirate labrum and 4 - 5 columellar folds. Length 8 - 12mm.

Conomitra namnetica (Cossmann, 1896)

1896. *Mitra namnetica* Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 6: 106, pl. 8, figs. 30, 31.
1901. *Conomitra namnetica* Cossmann, Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 94, pl. 10, fig. 23.

TYPE LOCALITY: Bois-gouet (Mid-Eocene of France).

A small, conoidal and ventricose species, sculptured with axial growth striae and spiral threads; labrum smooth, columella with 4 folds. This species has the appearance of a miniature *Waimatea othone* (Tenison-Woods). Length 5.25mm, width 2.5mm, height of aperture 3.0mm.

Conomitra tenuiplicata (Vasseur, 1881)

1881. *Mitra tenuiplicata* Vasseur, Rech. géol. terr. Tert. France, Paléont., Atlas, pl. 1, fig. 16.
1896. *Mitra tenuiplicata* Vasseur, Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 6: 105, pl. 9, fig. 18 (incomplete specimen).
1901. *Conomitra tenuiplicata* (Vasseur), Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 91, pl. 10, fig. 20.

TYPE LOCALITY: Bassin Campbon (Eocene of France).

The species is very similar to *Conomitra fusellina* (Lamarck) and *C.marginata* (Lamarck).

Conomitra textiliosa Cossmann & Pissarro, 1901

1901. *Conomitra textiliosa* Cossmann & Pissarro, Bull. Soc. géol. Normand., 20: 94, pl. 11, fig. 2.

TYPE LOCALITY: Fresville, Cotentin (Mid-Eocene of France).

The species is similar to *Conomitra apalachee* Gardner, from Lower Miocene deposits of Florida, but it is much smaller. It is sculptured with thin axial riblets and prominent bisecting spirals, the labrum is smooth and the columella has 4 folds. Length 8.5mm, width 3.5mm.

Conomitra vincentiana (Cossmann, 1881)

(Fig. 213)

1881. *Mitra vincentiana* Cossmann, J. Conchyl., 29: 170, pl. 7, fig. 6 (non Verco, 1896).
1889. *Mitra (Conomitra) vincenti* Cossmann, Ann. Soc. Roy. Malac. Belg., 24: 187, pl. 6, figs. 5, 6.
1899. *Conomitra vincenti* Cossmann, Ess. paléoc. comp., 3: 173, pl. 8, fig. 2.
1963. *Conomitra vincenti lukovitchi* Alekseev, Akad. Nauk Arm. SSR Erev., p. 122, pl. 22, figs. 1 - 10.

Fig. 213. *Conomitra vincentiana* (Cossmann, 1881). Auvers, M. Eocene of France; length 9.0mm (from Cossmann, 1881, pl. 7, fig. 6).

TYPE LOCALITY: Auvers, Paris Basin (Mid-Eocene of France) (*vincentiana*); Pre-Arals, Palaeogene of Russia (*lukovitchi*).

An ovate, ventricose species with arcuate axial ribs, *c.* 12 - 18 per whorl. a moniliform sutural girdle, smooth labrum and 5 distant columellar folds. Length 9.0mm, width 5.0mm.

Conomitra parva (J. de C. Sowerby, 1823)

(Plate 14, figs. 5 - 6)

1823. *Mitra parva* J. de C. Sowerby, Min. Conch., 5: 37, pl. 430, fig. 1.
1823. *Mitra pumila* J. de C. Sowerby, Min. Conch., 5: 37, pl. 430, fig. 2.
1856. *Mitra parva* Sowerby, Edwards, Palaeont. Soc. Engl. Mon., pt. 3: 183, pl. 24, figs. 1a-c.
1856. *Mitra parva* var. *pumila* Sowerby, Edwards, Paleont. Soc. Engl. Mon., pt. 3: 183, pl. 24, figs. 2a-c.
1856. *Mitra parva* var. *semilaevis* Edwards, Palaeont. Soc. Engl. Mon., pt. 3: 183.

TYPE LOCALITY: Barton Cliff (Bartonian, Upper Eocene of England) (*parva* and *pumila*); Barton, Alum Bay (*semilaevis*).

A small, plump and ovate species with girdled sutures, a lirate labrum and 4 - 5 columellar folds; the protoconch is small and nipple-like. Sculptured with prominent axial ribs and overriding spiral threads (Fig. 214); some specimens have an obsolete sculpture of axials and spirals (Fig. 214a), and in the variety *semilaevis* Edwards, the shell is almost smooth apart from a simple sutural girdle and basal striae. Length 4 - 7mm.

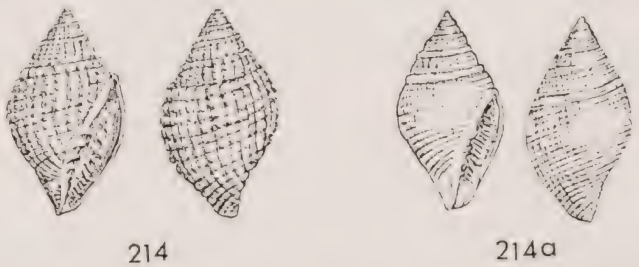

Fig. 214. *Conomitra parva* (J. de C. Sowerby). Barton, Eocene of England (plicate form). Fig. 214a. *C.parva* (J. de C. Sowerby). Barton, Eocene of England (smooth form). (From Edwards, 1856, pl. 24, figs. 1, 2).

Conomitra porrecta (F. E. Edwards, 1856)

(Fig. 215)

1854. *Mitra porrecta* Morris, Cat. Brit. Foss., ed. 2, p. 258 (nom. nud.).
1856. *Mitra porrecta* Edwards, Palaeont. Soc. Engl. Mon., pt. 3: 185, pl. 24, figs. 7a-c.

TYPE LOCALITY: Barton, Bracklesham Bay (Bartonian, Upper Eocene of England).

An elongate, slender and smooth species, with a simple sutural girdle and a few spiral striae at the shoulder and base of the body whorl; the labrum is lirate and the columella has 5 folds.

The holotype of *Conomitra porrecta* is in the Department of Geology, British Museum (Nat. Hist.), London, No. G-71190; the length is 7.7mm.

Fig. 215. *Conomitra porrecta* (Edwards). Barton, Eocene of England (after Edwards, 1856, pl. 24, fig. 7).

Conomitra alizalis (Anderson & Hanna, 1925)

1915. *Voluta* sp. Dickerson, Proc. California Acad. Sci., 5 (3): 76, pl. 11, fig. 15.
1925. *Mitra alizalis* Anderson & Hanna, Occ. Pap. California Acad. Sci., 11: 76.

TYPE LOCALITY: Loc. 244, Live Oak Creek, Kern County, California (Tejon formation, Upper Eocene of W. United States).

A small elongate ovate species with convex whorls, distinct axial ribs which number *c.* 23 on the body whorl, a smooth labrum and 4 columellar folds.

The holotype is in the California Academy of Sciences, San Francisco, No. 361; the given dimensions are length 4.7mm, width 3.1mm.

Conomitra fusoides (Lea, 1833)

(Plate 14, fig. 2)

1833. *Mitra fusoides* Lea, Contrib. Geol., p. 169, pl. 6, fig. 176 (plicate, broad form).
1890. *Mitra(Conomitra)fusoides lepa* de Gregorio, Ann. Géol. Paléont., 7: 72, pl. 5, figs. 35–36 (smooth, broad form).
1899. *Conomitra fusoides* (Lea), Cossmann, Ess. paléoc. comp., 3: 173, pl. 8, fig. 1.
1937. *Conomitra fusoides* (Lea), Palmer, Bull. Amer. Paleont., 7 (32): 408, pl. 66, figs. 19, 24-26.
1937. *Conomitra fusoides lepa* (de Gregorio), Palmer, Bull. Amer. Paleont., 7 (32): 409, pl. 66, figs. 23, 27-28.

TYPE LOCALITY: Claiborne, Alabama (*fusoides*); Gosport (*lepa*) (Mid-Eocene of S.E. United States).

The species is very variable in sculpture, both axial and spiral, some specimens being only obsoletely costate and striate, particularly on the body whorl; the sutural girdle may at times become obsolete. The species is the type species of *Conomitra* Conrad.

The lectotype of *Conomitra fusoides* is in the Academy of Natural Sciences, Philadelphia, No. 5868; the given dimensions are length 10.5mm, width 5.0mm. The holotype of *C.lepa* is in the University of Palermo, Italy.

Conomitra fusoides hammakeri (Harris, 1894)

1894. *Mitra hammakeri* Harris, Ann. Rept. Geol. Surv. Arkansas, 2: 163, pl. 6, fig. 4 (smooth form).
1926. *Conomitra jacksonensis* Cooke, J. Washington Acad. Sci., 16 (5): 134, fig. 6 (plicate form).
1947. *Conomitra hammakeri* (Harris), Harris & Palmer, Bull. Amer. Paleont., 30 (117): 402, pl. 56, figs. 13-16.
1947. *Conomitra jacksonensis* Cooke, Harris & Palmer, Bull. Amer. Paleont., 30 (117): 401, pl. 56, figs. 17-18.

TYPE LOCALITY: Lee Hammaker's well, Bradley County, Arkansas (Jackson formation, Upper Eocene of S.E. United States) (*hammakeri*); Moody's Branch, Jackson, Mississippi (*jacksonensis*).

The Jackson population of *C.fusoides* does not appear to differ from the Claiborne specimens in either sculpture or form. Harris & Palmer (1947), consider the more slender shape of the Jackson shells to be a constant distinction. The dimensions of the lectotype of *C.fusoides* (fide Palmer, 1937) are length 10.5mm and width 5.0mm; this is a width ratio of 48% of length, and the type of *C.fusoides* is therefore more slender than specimens of *C.hammakeri* figured by Harris & Palmer (*loc. cit.*, pl. 56, figs. 13, 16—width ratio 50% of length).

The holotypes of *C.hammakeri* USNM No. 135132, length 11.0mm, width 5.0mm, and *C.jacksonensis* USNM No. 353942, length 9.0mm, width 4.0mm, are in the U.S. National Museum, Washington.

Conomitra polita Vaughan, 1896

1896. *Conomitra polita* Vaughan, U.S. Geol. Surv. Bull., 142: 35, pl. 3, fig. 1.
1937. *Conomitra polita* Vaughan, Palmer, Bull. Amer. Paleont., 7 (32): 411, pl. 66, fig. 29.

TYPE LOCALITY: Georgetown, Lower Claiborne (Mid-Eocene of Louisiana, S.E. United States).

This species is probably synonymous with *Conomitra fusoides* (Lea); the differences in characters (absence of axial costae and greater columellar curve) are within the range of variation of *Conomitra* species, particularly individuals of different developmental stages.

The holotype is in the U.S. National Museum, Washington, USNM No. 147047.

Conomitra texana (Harris, 1895)

1895. *Turricula(Conomitra)texana* Harris, Proc. Acad. Nat. Sci. Philadelphia, 47: 69, pl. 6, fig. 11.
1937. *Conomitra texana* (Harris), Palmer, Bull. Amer. Paleont., 7 (32): 410, pl. 66, figs. 20-22.
1937. *Conomitra texana orangeburgensis* Palmer, Bull. Amer. Paleont., 7 (32): 410, pl. 66, figs. 12, 15.

TYPE LOCALITY: Well at College Sta., Brazos Co., Lower Claiborne (Mid-Eocene of Texas, S.E. United States) (*texana*); Orangeburg, Lower Claiborne (Mid-Eocene of Sth. Carolina, S.E. United States) (*orangeburgensis*).

The type figure of *C.texana* depicts an immature specimen resembling the slender, plicate form of *C.fusoides* (Lea). The subspecies *orangeburgensis* is based on variants of *C.texana* with nodose sutures and a concave trough below, i.e. the prominent development of a moniliform sutural girdle.

The holotype of *C.texana,* formerly in the University of Texas, has been lost (fide Palmer, 1937). The holotype of *C.texana orangeburgensis* and one paratype, are in the Paleontological Research Institute, Ithaca, No.'s 3251 and 3252.

Conomitra washingtoniana (Weaver, 1912)

1912. *Mitra washingtoniana* Weaver, Bull. Washington Geol. Surv., 15: 52, pl. 2, fig. 16.
1915. *Mitra washingtoniana* Weaver, Dickerson, Proc. California Acad. Sci., 5 (3): 75, pl. 11, figs. 11a, b.

TYPE LOCALITY: Cowlitz formation (Tejon group, Upper Eocene of Washington, N.W. United States).

There is some doubt about the assignment of this species to *Conomitra.* The axial ribs are distinct at the sutures of the body whorl and become obsolete towards the base; the columellar folds are thin and distant. There is a strong resemblance of the species to the Austral-Neozelanic *Waimatea* group of species and the Northern *Volutomitra.* Length 12.0mm, width 5.5mm.

Conomitra plicatella (Marshall & Murdoch, 1923)

(Plate 14, figs. 7 - 10)

1923. *Vexillum plicatellum* Marshall & Murdoch, Trans. N.Z. Inst., 54: 123, pl. 12, fig. 3.
1930. *Parvimitra plicatellum* (Marshall & Murdoch), Finlay, Trans. N.Z. Inst., 61: 65, pl. 3, figs. 34-36.
1930. *Parvimitra subplicatellum* Finlay, Trans. N.Z. Inst., 61: 64, pl. 3, figs. 43-45.
1930. *Parvimitra allani* Finlay, Trans N.Z. Inst., 61: 65, pl. 3, fig. 42.

TYPE LOCALITY: Greensands immediately below the limestone, McCullough's Bridge, Waihao River (Kaiatan, Upper Eocene of New Zealand) (*plicatella*); McCullough's Bridge, greensand below limestone (*subplicatella*); McCullough's Bridge, greensand below limestone (*allani*).

Shell small, 5 - 9mm, elongate ovate or fusiformly elongate, width 40 - 52% of length; teleoconch of $3\frac{1}{2}$ - $4\frac{1}{2}$ convex or occasionally subangulate whorls, protoconch of $1\frac{1}{2}$ - 2 smooth, bulbous nuclear whorls. Sculptured with angulate axial ribs and spiral threads, ribs becoming sometimes obsolete on the last two whorls and indicated by irregular axial growth striae or thin threads; penultimate whorl with up to 20 axial ribs, body whorl with 22 ribs. The spiral threads are prominent in some individuals and obsolete in others, and when present, number from 3 - 8 on the penultimate whorl and from 15 - 30 on the body whorl. Some specimens, particularly those with a prominent spiral sculpture, carry a spiral girdle near the sutures. Aperture narrow, longer than the spire, 55 - 66% of total length, smooth within; labial lip thin and simple, columella with 4 thin and distant folds, posterior fold generally shorter than the second fold.

Parvimitra subplicatella, described by Finlay (1930) from the same deposits as *Conomitra plicatella,* was separated on characters of squat shape and stronger spiral sculpture. Even a short series of *C.plicatella* will exhibit a range of variation in sculpture and shape, particularly in juveniles, which are broader than adults. The holotype and 14 paratypes of *Parvimitra subplicatella* Finlay, are in the Auckland Institute & Museum, No. TM-593. The holotype has a large portion of the labial lip missing; the dimensions are length 6.4mm, width 3.1mm, height of aperture 4.3mm.

Parvimitra allani Finlay, differs from *Conomitra plicatella* only in being more slender. The type series of *Parvimitra allani* consists of 6 specimens, and the most atypical specimen has been selected

by Finlay as the holotype. This specimen has a large portion of the labial lip missing and two repair scars on the ventral side of the body whorl; three of the paratypes are distorted through lateral compression and only 2 paratypes are normal specimens. The width ratio of these selected 6 specimens ranges from 36 - 44% of shell length, and only the distorted specimens fall outside the width range of *Conomitra plicatella*. The last two whorls in the holotype of *Parvimitra allani* are not smooth as pointed out by Finlay (*loc. cit.*), but are axially plicate; the axials become obscure on the body whorl and take on the form of thin axial threads and growth striae. The holotype No. TM-588 is in the Auckland Institute & Museum; the dimensions are length 8.2mm, width 3.1mm, height of aperture 4.6mm. The body whorl has 16 axial threads and 18 spirals and the penultimate whorl 10 axials and 6 spiral threads.

Conomitra staminea (Conrad, 1848)

1848. *Mitra staminea* Conrad, Proc. Acad. Nat. Sci. Philadelphia, 3: 289.
1848. *Mitra vicksburgensis* Conrad, Proc. Acad. Nat. Sci. Philadelphia, 3: 289.
1848. *Mitra staminea* Conrad, J. Acad. Nat. Sci. Philadelphia, 1 (2): 120, pl. 12, fig. 4.
1848. *Mitra vicksburgensis* Conrad, J. Acad. Nat. Sci. Philadelphia, 1 (2): 120.
1887. *Conomitra angulata* Heilprin, Trans. Wag. Free Inst. Sci., 1: 100, pl. 15, fig. 47.
1890. *Conomitra staminea* (Conrad), Dall, Trans. Wag. Free Inst. Sci., 3: 94, pl. 4, fig. 2 (spec. juv.).

TYPE LOCALITY: Vicksburg, Mississippi (Mid-Oligocene of S.E. United States) (*staminea* and *vicksburgensis*); Silex beds at Ballast Point (Lower Miocene of Florida, S.E. United States) (*angulata*).

The species is larger and less prominently sculptured than the Eocene *Conomitra fusoides* (Conrad); the size of specimens ranges from 10 - 18mm. The specimen figured by Dall (1915, pl. 10, fig. 2) as *C.staminea* appears to be the same species as *C.apalachee* Gardner, 1937.

Conomitra inornata (Beyrich, 1854)

1854. *Mitra inornata* Beyrich, Zeit. deut. geol. Gesell., 6 (2): 413; 1853, 5: pl. 9, figs. 2a, b.
1890. *Mitra inornata* Beyrich, Koenen, Abh. geol. Spec. Preuss. Thür. Staat., 10 (2): 536, pl. 38, figs. 4a-c, 5a-c.

TYPE LOCALITY: Westeregeln, Magdeburg (Tongrian, Lower Oligocene of Germany).

A small, smooth species, sculptured only with axial growth lines, a presutural groove and basal striae; the labrum is lirate, and the columella has 5 distant folds, first posterior fold smaller and shorter than the second fold. Length 4.0 - 6.0mm.

Conomitra extensa (Koenen, 1890)

1890. *Mitra extensa* Koenen, Abh. geol. Spec. Preuss. Thür. Staat., 10 (2): 538, pl. 38, figs. 7a-c.

TYPE LOCALITY: Lattorf (Tongrian, Lower Oligocene of Germany).

This species is probably synonymous with *Conomitra inornata* (Beyrich). It is similar in all respects, but has additional obscure spiral striae. Length 5.4mm, width 2.1mm.

Conomitra perminuta (Sandberger, 1863)

1863. *Mitra perminuta* "Braun", Sandberger, Conch. Mainz. Tert., p. 252, pl. 19, fig. 4.
1865. *Mitra perminuta* Braun, Deshayes, Desc. Anim. s. vert. Bass. Paris, 3 (2): 103, pl. 103, figs. 23-25.
1890. *Mitra perminuta* Braun, Koenen, Abh. geol. Spec. Preuss. Thür. Staat., 10 (2): 540, pl. 38, figs. 1a-c.

TYPE LOCALITY: Weinheim, Waldböckelheim (Rupelian, Mid-Oligocene of Germany).

A smooth species with 2 bulbous nuclear whorls, striae at the base, a smooth or lirate labrum and 4 distant columellar folds. Length up to 10.0mm.

The species has been recorded from the Lower Oligocene of Belgium and Germany, Mid Oligocene of France and Germany and Upper Oligocene of Hungary.

Conomitra ravni (Harder, 1913)

1913. *Mitra ravni* Harder, Danm. Geol. Unders., 22: 84, 129, pl. 7, figs. 2a-c, 3
1950. *"Mitra" ravni* Harder, Beets, Meded. geol. Sticht., 4 (8): 30.

TYPE LOCALITY: Aarhus (Oligocene of Denmark).

An ovate and moderately smooth species with 4 distant columellar folds. Length *c.* 6.0mm.

Conomitra secalina (Koenen, 1890)

1890. *Mitra secalina* Koenen, Abh. geol Spec. Preuss. Thür. Staat., 10 (2): 539, pl. 38, figs. 6a-c (non Gould, 1860).

TYPE LOCALITY: Lattorf, Unseburg (Tongrian, Lower Oligocene of Germany).

The species is elongate ovate, moderately smooth apart from axial growth striae and basal cords; the protoconch has 2½ smooth and bulbous nuclear whorls, with the initial turn slightly tilted. The sutures are girdled, the labrum is lirate and the columella has 5 folds, the first posterior fold being shorter than the second fold. Length 5.6mm, width 2.2mm.

Mitra secalina Koenen is a homonyn of *M.secalina* Gould; since there may be an available junior synonym, no substitute name is proposed.

Conomitra semimarginata (Beyrich, 1854)

1854. *Mitra semimarginata* Beyrich, Zeit. deut. geol. Gesell., 6 (2): 96; 1853, 5: pl. 8, figs. 7a, b.

TYPE LOCALITY: Mecklenburg, Sternberg formation (Chattian, Upper Oligocene of Germany). Length 7.6mm, width 3.0mm.

Conomitra sulcifera (Koenen, 1890)

1890. *Mitra sulcifera* Koenen, Abh. geol. Spec. Preuss. Thür. Staat., 10 (2): 535, pl. 38, figs. 2a-c.

TYPE LOCALITY: Lattorf (Tongrian, Lower Oligocene of Germany).

Shell small, 8 - 9mm, elongate ovate, teleoconch of 5½ flat-sided whorls, protoconch of 1½ smooth, globose nuclear whorls; sculptured with obsolete axial ribs or growth striae which tend to become nodulose at sutures, flat cords at the base and a distinct sutural girdle. Aperture narrow, lirate within, labial lip smooth and simple, contracted anteriorly; columella with 4 distant folds, first posterior fold shorter than the second fold. Length 8.4mm, width 3.3mm.

Conomitra peyreirensis Peyrot, 1928

1928. *Conomitra peyreirensis* Peyrot, Act. Soc. Linn. Bordeaux, 78: 330, pl. 7, figs. 8, 9.
1961. *Vexillum(Conomitra)peyreirensis* (Cossmann & Peyrot), Báldi, Kecskeméti, Nyirö & Drooger, Ann. Hist. Nat. Mus. Nat. Hung., 53: 103, pl. 4, fig. 11.

TYPE LOCALITY: Peyrehorade (Aquitanian, Lower Miocene of France); also Lower Miocene of Hungary.

A smooth species, sculptured only with obsolete spiral striae and a simple sutural girdle; the labrum is lirate and the columella has 4 - 5 irregular, distant folds. Length 8.0 - 9.0mm.

The species is very similar to the Australian *Conomitra pentaploca* (Finlay).

Conomitra pentaploca (Finlay, 1927)

(Plate 14. fig. 12)

1889. *Mitra ligata* Tate, Trans. Roy. Soc. Sth. Australia, 11: 139, pl. 5, fig. 4 (non A. Adams, 1853).
1897. *Conomitra ligata* Tate, Harris, Cat. Tert. Moll. Brit. Mus., p. 130.
1927. *Microvoluta pentaploca* Finlay, Trans. N.Z. Inst., 57: 508 (nom. subst. pro *Mitra ligata* Tate, 1889).

TYPE LOCALITY: Lower beds at Muddy Creek (Balcombian, Mid-Miocene of Victoria, S.E. Australia).
DISTRIBUTION: Blue clays at Schnapper Point; Balcombe Bay; Altona Bay (Miocene of Victoria).

Shell small, 5 - 7mm, elongate ovate, biconic and shining, width 43 - 50% of length; teleoconch of 4 - 5 almost flat-sided whorls, protoconch of 1½ - 2 smooth and globose nuclear whorls. Sculptured with a smooth sutural girdle, arcuate axial growth striae which develop into thin riblets on early whorls in some specimens, and fine spiral striae which number about 20 on the body whorl; the spiral striae obsolete or quite distinct. Aperture narrow, equal in height or longer than the spire, 52 - 61% of total length, labrum prominently lirate; labial lip thin and simple, constricted anteriorly, columella with 4 - 5 thin and distant folds, first posterior fold shorter than second fold, columellar beak slightly twisted towards aperture.

The holotype is presumably in the Tate Museum collection at the University of Adelaide, Sth. Australia; the given dimensions are length 7.0mm, width 3.0mm, height of aperture 4.0mm.

Conomitra wainuioruensis (Vella, 1954)

(Plate 14, fig. 11)

1954. *Vexillitra wainuioruensis* Vella, Trans. Roy. Soc. N.Z., 81 (4): 545, pl. 26, fig. 15.

TYPE LOCALITY: N 166/535, lower Wainuioru River, uppermost beds of Hurupi formation, Basal Tongaporutuan (Upper Miocene of New Zealand).

"Small, biconic, rather thin, glossy. Six whorls including protoconch of 1½ whorls. Early post-nuclear whorls have broad, low, rounded, vertical axial ribs (24 on second post-nuclear whorl) which become obsolete on later whorls, hardly discernible on the penultimate and lacking on the body whorl. Shoulder level, narrow; peripheral girdle weak, at first moniliform, but becoming smooth as the axials weaken. Body whorl descending nearly vertically from the peripheral girdle then contracting rapidly to the canal." (Original description). Length 6.1mm, width 3.4mm.

Conomitra wainuioruensis is similar in many features to the Australian Miocene *C.pentaploca*; both species have the canal slightly recurved, but in *C.pentaploca* the spiral girdle is situated at the sutures in adult specimens, not on the presutural ramp, and axial sculpture consists of growth striae or thin riblets and not broad ribs. The aperture of *C.wainuioruensis* appears to be filled with matrix, and one cannot determine whether the labrum is smooth or lirate.

The unique and somewhat immature holotype is in the N.Z. Geological Survey collection, Lower Hutt.

The following species are tentatively assigned to *Conomitra*.

Conomitra antigua Doncieux, 1908. Eocene of France.
C.antiqua Doncieux, 1908. Eocene of France.
Mitra concinna Beyrich, 1854 (non Reeve, 1844). Oligocene of Germany.
M.cotteaui Cossmann & Lambert, 1884 (syn. *umbilicata* Cossmann & Lambert, 1884). Oligocene of France.
Fusimitra danensis Cossmann, 1899 (syn. *semilaevis* Koenen, 1885 = *danica* Ravn, 1939). Paleocene of Denmark.
Mitra delbosi Roualt, 1850. Eocene of France.
M.gaasensis Vergneau-Saubade, 1968. L. Miocene of France.
M.godini Cossmann, 1891. Eocene of France.
Conomitra guizehensis Cuivillier, 1933. U. Eocene of Egypt.
Mitra hordeola Deshayes, 1865. Eocene of France.
M.hypermeces Cossmann, 1896. Eocene of France.
M.inaspecta Deshayes, 1865. Eocene of France.
Conomitra nincki Cossmann, 1913. Eocene of France.
Mitra quinqueplicata Ravn, 1902. Paleocene of Denmark.
M.soellingensis Speyer, 1864. Oligocene of Germany.
M.suturalis Bosquet, 1859. Oligocene of Holland.
M.tetraptyca Cossmann, 1885. Eocene of France.
Conomitra tracyi Harris, 1899. Eocene of Alabama, S.E. United States.
C.vandervlerki Martin, 1931. Eocene of Java, Indonesia.
C.weeksi F. Hodson in Hodson & Hodson, 1931. ? Oligocene of Venezuela.

Genus Peculator Iredale, 1924

Peculator Iredale, 1924, Proc. Linn. Soc. N.S.W., 49 (3): 269. Type species by M *P.verconis* Iredale, 1924. Recent, S.E. Australia.

= 1955. *Peculata* Kershaw, Pap. Proc. Roy. Soc. Tasmania, 89: 318 (nom. null.).
= 1958. *Peculata* Macpherson in May, Illust. Ind. Tasman. shells, p. 41 (nom. null.).

Shell small, 3 - 11mm, ovate, obese or cylindrically ovate, teleoconch of 3 - 4½ convex whorls, protoconch of 1½ - 2 smooth, depressed, globose nuclear whorls. Sculptured with irregular axial growth striae or thin riblets, and close-set spiral striae; sutures occasionally with a moniliform or smooth girdle. Aperture narrow and elongate, longer than the spire, smooth within, labial lip thin and simple; columella slightly calloused and with 3 - 4 strong but distant folds, first posterior fold generally shorter than second fold. Siphonal canal straight or slightly recurved, siphonal notch feeble or absent. Periostracum thin and brown in colour, the operculum (*fide* Verco, 1896) small and elongate. Radula unknown.

Peculator is an offshoot of Miocene *Conomitra* stock, probably of the *Parvimitra* group of species. *Peculator* is confined to the Austral-Neozelanic region, and contains 4 living and 2 fossil species.

Geographical distribution: Australia and New Zealand. Lat. 30° - 44° S.

Stratigraphical range: Lower Miocene - Recent.

Habitat: In sand and rubble, from 6 - 260 metres (3 - 142 fathoms), at *c.* 15°C (59°F).

Peculator porphyria (Verco, 1896)

(Plate 14, figs. 13 - 14)

1896. *Imbricaria porphyria* Verco, Trans. Roy. Soc. Sth. Australia, 20: 227, pl. 8, figs. 5, 5a.
1923. *Imbricaria porphyria* Verco, May, Illust. Ind. Tasman. shells, p. 79, pl. 37, fig. 23.
1924. *Marginella coma* Odhner, Vid. Medd. Dansk nat. For., 77: 42, pl. 1, fig. 28.
1932. *Peculator porphyria* (Verco), Cotton & Godfrey, Sth. Austral. Nat., 13 (2): 81, pl. 4, fig. 4.
1937. *Peculator coma* (Odhner), Powell, Discov. Repts., 15: 212.
1957. *Peculator porphyria* (Verco), Cotton, Roy. Soc. Sth. Austral. Malac. Sect., p. 6, fig. 8.

type locality: In and outside Backstairs Passage, Investigators Straits, 15 - 20 fathoms (27 - 37 metres) (*porphyria*); 10 miles (16km) N.W. Cape Maria van Diemen, North Island, New Zealand, 50 fathoms (92 metres) (*coma*).

distribution: Australia—off Wilson's Promontory, Victoria; St. Vincent's Gulf, S.A.; Port Willunga, S.A.; west coast of Yorke's Peninsula, S.A.; Great Australian Bight, S.A.; 85 metres (46 fathoms); W. of Cape Leschenault, S.W.A., 47 - 49 fathoms (86 - 90 metres); off Thouin Bay, Tasmania, 40 fathoms (73 metres). New Zealand—off Three Kings Islands, 185 metres (101 fathoms); between Spirits Bay and Three Kings Islands, 95 metres (52 fathoms); off Spirits Bay, 59 metres (32 fathoms), at 14.8°C (59°F).

Shell small, 4 - 11mm, ovate and obese, width 57 - 63% of length; dead shells white, showing occasionally remnants of orange-brown zones, but live-taken shells uniformly mauve or dark fawn in colour, flecked with white or light violet, horizontally oriented spots. Teleoconch of 3 - 4½ flat-sided to slightly convex whorls, protoconch of 1½ - 2 smooth, globose, dome-shaped nuclear whorls. Sculptured with numerous, close-set axial growth striae, fine axial threads and spiral striae; the spiral sculpture generally more prominent in the vicinity of the sutures and towards the canal. In some individuals, the axial growth striae tend to become elevated axial riblets in some parts of the shell; juvenile shells more prominently striate, with up to 25 spiral striae on the body whorl and fine granules on early whorls. Aperture longer than the spire, 60 - 73% of total length, moderately narrow and smooth within; in juvenile shells, the aperture sometimes equals in height the spire. Labial lip thin and simple, convex, columella slightly calloused and with 3 - 4 moderately strong folds, the first posterior fold usually the shortest, the anterior fold the smallest. Siphonal canal straight, notch only feebly developed or absent. Operculum as figured by Verco (1896) and Cotton (1957), slender and elongate, blunt or pointed at the end.

The holotype of *Peculator porphyria* is in the South Australian Museum, Adelaide; the given dimensions are length 10.0mm, width 5.75mm, height of aperture 7.25mm.

The holotype of *Peculator coma* is in the University Museum, Copenhagen; the given dimensions are length 5.4mm, width 3.4mm.

Peculator hedleyi (Murdoch, 1905)

(Plate 14, figs. 15 - 16)

1905. *Vulpecula(Pusia)hedleyi* Murdoch, Trans. N.Z. Inst., 37: 228, pl. 8, fig. 21.
1913. *Mitra hedleyi* (Murdoch), Suter, Man. N.Z. Moll., p. 361, 1915, Atlas, pl. 18, fig. 3.
1936. *"Mitra" bicornis* Laws, Trans. Roy. Soc. N.Z., 66: 113, pl. 16, fig. 66.
1937. *Peculator hedleyi* (Murdoch), Powell, Shellf. New Zeal., p. 77.
1937. *Egestas dissimilis* Powell, Discov. Repts., 15: 211, pl. 55, fig. 8.
1966. *"Mitra" bicornis* Laws, Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: Whangarei Heads, Nth. Island, N.Z., shallow water (*hedleyi*): Kaawa Creek, Port Waikato (Opoitian, Lower Pliocene of New Zealand) (*bicornis*); off Three Kings Islands, St. 933, in 260 metres (142 fathoms) (*dissimilis*).

DISTRIBUTION: Whangaroa Harbour, 3 - 4 fathoms (5 - 7 metres); ½ mile (0.8km) south side of Stephenson I., Whangaroa, 22 fathoms (40 metres); Urupukapuka I., Bay of Islands, coral sand, 3 fathoms (5 metres); Whangarei Heads; off Awanui Heads, 12 fathoms (22 metres); near Little Barrier Island, 20 fathoms (37 metres); Tryphena, Gt. Barrier I., 30 fathoms (55 metres); Tuhua reef, Mayor I., ex-pisces, 35 fathoms (64 metres).

The species differs from *Peculator porphyria* only in being more slender and less inflated. Shells are either dark brown or purplish-brown in colour, and ornamented with horizontally oriented white or light violet spots. The width ratio of *P.hedleyi* ranges from 48 - 59% of length in comparison to a width index of 57 - 63% of length of *P.porphyria*. We are not convinced that *P.hedleyi* is a valid biospecies, and suspect that it is only a slender form of *P.porphyria*. Although individuals of *P.hedleyi* are generally more slender, there is an overlap in the 57 - 59% width index; both forms are sympatric at Three Kings Islands. Large series of *P.porphyria* are not at the writer's disposal, but slender individuals of *P.porphyria* may have been recorded in Australian populations of the species. In New Zealand, the broad *coma* form has been recorded from deep water only, whereas live specimens of the slender *hedleyi* have been obtained in comparatively shallow water; the specimens of *P.hedleyi* dredged from 260 metres (142 fathoms) off the Three Kings Islands were all dead specimens.

Peculator bicornis was separated specifically from *P.hedleyi* on features of larger size, greater width nearer the anterior of the body whorl, less distinct siphonal notch and differences in columellar plait arrangement. In size, *P.bicornis* is only a fraction of a mm larger than the largest specimen of *P.hedleyi* on record; the maximum width in either *P.porphyria* or *P.hedleyi* can be either at the shoulder or displaced more anteriorly. In the majority of mature specimens of *P.hedleyi* the first posterior fold is shorter than the second fold, and the anterior fold is the smallest; the siphonal notch is always feebly developed or even absent in *P.hedleyi*. It is impossible to find a single constant character which would permit easy separation of the Pliocene *P.bicornis* from the Recent *P.hedleyi*. The holotype of *P.bicornis* (Laws), is in the Department of Geology, Auckland University, No. G-5843; the dimensions are length 9.5mm, width 4.7mm, height of aperture 6.7mm, and the spire is fractured.

Specimens of *Egestas dissimilis* Powell, are dead, faded and juvenile examples of *Peculator hedleyi*. The holotype of *Egestas dissimilis* is in the British Museum (Nat. Hist.), London; the dimensions are length 2.8mm, width 1.45mm. Paratypes of the species are in the Powell collection, Auckland Institute & Museum, No. TP-293.

The holotype of *Peculator hedleyi* (Murdoch), is in the Dominion Museum, Wellington, No. M-1737; the dimensions are length 5.3mm, width 2.7mm, height of aperture 3.6mm. The type is faded, slightly immature and the brown and white pattern is barely distinguishable; the spiral striae tend to become obsolete towards the centre of the body whorl, and the columella has 4 distant folds.

Peculator verconis Iredale, 1924

(Plate 14, fig. 17)

1924. *Peculator verconis* Iredale, Proc. Linn. Soc. N.S.W., 49 (3): 269, pl. 34, fig. 5.
1962. *Peculator verconis* Iredale, Iredale & McMichael, Austral. Mus. Mem., No. 11: 64.

TYPE LOCALITY: Twofold Bay, N.S.W., Australia, 15 - 25 fathoms (27 - 46 metres).

DISTRIBUTION: Disaster Bay, N.S.W., 10 - 20 fathoms (18 - 37 metres).

The species is closely allied to *Peculator porphyria* (Verco), and differs only in the more prominent axial ribs in contrast to the usual growth striae in *P.porphyria*. Two specimens of *P.hedleyi* from Whangarei Heads, New Zealand, although smaller in size than *P.verconis*, had 17 elevated axial riblets on the body whorl. Besides the dead-collected, faded type, only a few Twofold Bay specimens were available for examination. The holotype of *P.verconis* is in the Australian Museum, Sydney, No. C-65643; the dimensions are length 11.0mm, width 5.8mm, height of aperture 7.8mm. The type is pinkish-white and faded, with one row of 6 orange blotches at the suture of the body whorl and a second row of 7 blotches towards the base. The teleoconch has 4 slightly convex whorls, and the protoconch 2 dome-shaped nuclear whorls; the body whorl is sculptured with 21 irregular axial ribs and the penultimate whorl with 24 ribs. There are 5 - 6 spiral striae on the penultimate whorl, 7 striae at the sutures of the body whorl and 12 striae towards the base; the columella has 3 folds and an indication of a very small fourth fold. The width index is 52 - 55% of length, and is intermediate between *P.hedleyi* and *P.porphyria*; the height of the aperture is the same as in *P.porphyria*. Other Twofold Bay specimens examined were even more prominently sculptured than the type.

Peculator verconis is the type species of *Peculator* Iredale. Iredale (1924) described his new species as "a close ally of *Imbricaria porphyria* Verco, and probably the Peronian representative of that species". Only the further collection of living specimens of the species may solve its taxonomic position.

Peculator obconicus (Powell, 1952)

(Plate 14, fig. 18)

1952. *Microvoluta obconica* Powell, Rec. Auckland Inst. Mus., 4 (3): 183, pl. 36, fig. 2.

TYPE LOCALITY: Off Spirits Bay, Northland, 30 fathoms (55 metres).

DISTRIBUTION: Off Three Kings Islands, 260 metres (142 fathoms).

Shell small, 5 - 7mm, ovate and inflated, width 51 - 55% of length, white in colour, ornamented with thin and wavy, yellowish-brown axial lines which are continuous from suture to base, or are arranged in 3 spiral zones of chevron-shaped lines. Teleoconch of $3\frac{1}{2}$ - $4\frac{1}{2}$ convex whorls, protoconch of $1\frac{1}{2}$ smooth and dome-shaped nuclear whorls. Sculptured with irregular axial ribs, 4 - 10 on the body whorl, 12 - 15 on the penultimate whorl; penultimate whorl with 4 - 5 finely incised spiral grooves, body whorl with 6 - 9 spirals and *c.* 6 oblique cords on the siphonal canal, and the sutures with an impressed but shallow girdle. Aperture moderately narrow, longer than the spire, 60 - 67% of total length, smooth within, labial lip thin and simple; the columella with 4 folds, the posterior one shorter than the second fold, siphonal notch absent.

Peculator obconicus shares the features of obese form, long aperture, sculpture and colouring with other *Peculator* species, and an assignment of the species to *Peculator* rather than *Microvoluta* is more appropriate. The sutural girdle, although not present in other Recent *Peculator* species, appears to be a variable sculptural ornament in *Microvoluta* and *Peculator*, and is always present in the Tertiary *P.cassida* (Tate).

The holotype of *Peculator obconicus* is in the Auckland Institute & Museum, No. TM-1194; the dimensions are length 5.0mm, width 2.8mm, height of aperture 3.2mm, and the specimen is immature.

Peculator cassida (Tate, 1889)

(Plate 14, fig. 20)

1889. *Mitra cassida* Tate, Trans, Roy. Soc. Sth. Australia, 11: 144, pl. 6, fig. 5.

TYPE LOCALITY: Upper beds at Muddy Creek (Pliocene of Victoria, S.E. Australia).

DISTRIBUTION: Bird Rock, Upper beds, Lower Miocene of Victoria.

Shell small, 5 - 7mm, ovate, biconic, width 51 - 56% of length; teleoconch of 3½ - 4 slightly convex whorls, protoconch of 1½ - 2 smooth, globose, dome-shaped nuclear whorls. Sculptured with slender and irregular axial riblets, 12 - 26 on the body whorl, 18 - 28 on the penultimate whorl; axial ribs tending to become subobsolete on the body whorl, and at the point of intersection with the suture forming a moniliform girdle. Spiral striae numbering 2 - 3 on the penultimate whorl, on the body whorl the striae confined to the suture. Aperture narrow, longer than the spire, 69 - 74% of total length, smooth within; columella with 4 folds, first posterior fold short, siphonal canal straight, siphonal notch absent.

Peculator cassida is clearly referable to the *Peculator* group, and in many aspects is similar to *P.verconis* Iredale, but differs in the feature of moniliform sutures. In some specimens of *P.cassida* the axial riblets are feebly developed and almost reduced to growth striae on the body whorl; in some individuals, particularly juveniles, the axial riblets are numerous and quite distinct.

The holotype of *Peculator cassida* is presumably in the Tate Museum collection at the University of Adelaide, South Australia; the given dimensions are length 7.0mm, width 4.0mm, height of aperture 5.5mm.

Peculator clifdenensis (Finlay, 1930)

(Plate 14, fig. 19)

1930. *Parvimitra clifdenensis* Finlay, Trans. N.Z. Inst., 61: 65.
1966. *Parvimitra clifdenensis* Finlay, Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: Clifden, band 7A, Southland (Lillburnian, Mid-Miocene of New Zealand).

Shell small, 5 - 6mm, ovate and obese, width *c.* 50% of length; teleoconch of 3½ convex whorls, protoconch of 1½ smooth and dome-shaped nuclear whorls. Sculptured with slender and irregular axial riblets, 23 on the body whorl, 20 on the penultimate whorl; spiral striae absent. Aperture narrow, longer than the spire, *c.* 65 - 66% of total length, smooth within; labial lip thin and crescent-shaped. Columella with 4 distinct folds, siphonal canal straight, siphonal notch very feeble.

Peculator clifdenensis lacks the angulate and often cingulate presutural ramp of *Parvimitra*. The holotype is in the Auckland Institute & Museum, No. TM-589; the dimensions are length 5.2mm, width 2.6mm, height of aperture 3.4mm.

GENUS Microvoluta Angas, 1877

Microvoluta Angas, 1877, Proc. Zool. Soc. Lond., p. 34. Type species by M *M.australis* Angas, 1877. Recent, S.E. Australia.

= 1928. *Mitravoluta* Preston, Zool. Record, 64: 70 (nom. null.).

Shell small to very small, 4 - 15mm, fusiformly elongate to fusiformly ovate, teleoconch of 4 - 7 convex, flat-sided or concavo-convex whorls, protoconch of 1½ - 2 smooth, glassy, globose nuclear whorls. Smooth, or sculptured with axial costae and spiral striae, presutural ramp occasionally nodulose, sutures frequently with a smooth girdle. Aperture narrow, shorter or longer than the spire, smooth or lirate within; labial lip thin and simple, angulate or constricted basally, columella with 3 - 5 irregular and distant folds. Siphonal canal frequently recurved towards the aperture in adult specimens, siphonal canal spout-shaped, notch absent or very feeble. Variable in colour, generally banded, blotched or streaked with brown.

The radula (Fig. 188) is similar to *Volutomitra*, rachidians are wishbone-shaped and with a large single cusp, laterals (fide Peile, 1922) absent. Operculum not recorded.

The genus contains 8 Recent and 3 fossil species.

GEOGRAPHICAL DISTRIBUTION: Caribbean; South Africa; Philippines; Australia; New Zealand (Recent). Lat. 10° - 25° N and Lat. 34° - 44° S.

STRATIGRAPHICAL RANGE: Pliocene - Recent.

HABITAT: In mud and sand, from 9 - 930 metres (5 - 508 fathoms), at 6° - 20°C (43° - 68°F).

Microvoluta australis Angas, 1877

(Plate 15, figs. 1 - 3)

1877. *Microvoluta australis* Angas, Proc. Zool. Soc. Lond., p. 35, pl. 5, fig. 2.

1887. *Voluta minima* Sowerby, Thes. Conchyl., 5: 300, pl. 515 (16), figs. 152, 152a (nom. subst. pro *Microvoluta australis* Angas, 1877).

1903. *Microvoluta australis* Angas, Hedley, Mem. Austral. Mus., 4 (6): 371.

1908. *Microvoluta purpureostoma* Hedley & May, Rec. Austral. Mus., 7: 120, pl. 23, figs. 20, 21 (spec. juv.).

1922. *Microvoluta australis* Angas, Peile, Proc. Malac. Soc. Lond., 15: 17, fig. 8 (radula).

TYPE LOCALITY: Port Jackson, in 25 fathoms (46 metres) (*australis* and *minima*); 7 miles east of Cape Pillar, Tasmania, 60 - 100 fathoms (110 - 183 metres) (*purpureostoma*).

DISTRIBUTION: Off Broughton Island, 35 fathoms (64 metres); off Cabbage Tree Island, N.S.W., 24 fathoms (44 metres); Newcastle Bight, N.S.W., 16 - 19 fathoms (29 - 35 metres); Port Jackson, N.S.W., 25 fathoms (46 metres); off Cronulla, N.S.W., 40 - 100 metres (22 - 55 fathoms); off Port Kembla, N.S.W., 63 - 75 fathoms (115 - 137 metres); Twofold Bay, N.S.W., 5 - 15 fathoms (9 - 27 metres); Green Cape, N.S.W., 50 - 70 fathoms (92 - 128 metres); off Lakes Entrance, Victoria, 20 - 25 fathoms (37 - 46 metres).

Shell small, 6 - 11mm, elongate ovate, width 42 - 48% of length; variable in colour, generally off white, ornamented with wavy, zigzag brown lines, and occasionally 2 - 3 spiral rows of dark blotches; juvenile shells often uniformly brown. The base of the siphonal canal dark brown, and nuclear whorls occasionally purple. Teleoconch of 4 - 5 convex whorls, protoconch of $1\frac{1}{2}$ - 2 smooth and globose nuclear whorls. Smooth, or sculptured with irregular axial growth striae and fine spiral threads; the spiral striae may be confined to the sutures and the base, but some specimens spirally striate from suture to the base. Aperture narrow, equal in height or longer than the spire, 52 - 65% of total length, smooth and brown within; labial lip thin and simple, slightly contracted towards the siphonal canal, canal ill-defined and lacking a notch; columella with generally 4 thin and irregular folds, siphonal canal occasionally twisted towards the aperture. Operculum unknown.

The radula (Fig. 188) is basically the same as the radula of *Volutomitra groenlandica* (Beck in Möller). Peile (1922) did not show lateral teeth, and it is presumed that *Microvoluta australis* lacks laterals.

The type of *Microvoluta australis* is in the British Museum (Nat. Hist.) London. The holotype of *M.purpureostoma* Hedley & May, is in the Australian Museum, Sydney, No. C-29064; the dimensions are length 6.4mm, width 2.9mm, height of aperture 3.6mm. The type is worn and faded, with 4 mature and 2 nuclear whorls, 4 spiral striae on the penultimate whorl, 3 striae at the suture and 9 striae at the base of the body whorl, and the columella has 4 thin and distant folds. The specimen is a juvenile of *M.australis;* juvenile specimens are uniformly brown, fragile and slightly broader than adult specimens.

Microvoluta complanata (Tate, 1889)

(Plate 15, fig. 4)

1889. *Mitra complanata* Tate, Trans Roy. Soc. Sth. Australia, 11: 138, pl. 5, fig. 12.

TYPE LOCALITY: Clayey green sands, Adelaide bore (Pliocene of Sth. Australia).

"Shell rather thin, elongate-ovate, with a blunt apex, and rather attenuated at the front; whorls six, smooth, shining, slightly convex. Aperture narrow - elliptical; outer lip sharp, smooth within; columella with four distant plaits." (Original description).

Microvoluta complanata resembles immature specimens of *M.australis*. Since its original description, this species has not been re-described or included in Pliocene faunal lists.

The holotype is presumably in the Tate Museum collection at the University of Adelaide, South Australia; the given dimensions are length 8.0mm, width 3.5mm, height of aperture 5.0mm.

Microvoluta subcrenularis (Tate, 1889)

(Plate 15, fig. 5)

1889. *Mitra subcrenularis* Tate, Trans. Roy. Soc. Sth. Australia, 11: 142, pl. 5, fig. 6.

TYPE LOCALITY: Clayey green sands, Adelaide bore (Pliocene of Sth. Australia).

"Shell rather thin, broadly fusiform, ending in a blunt papillary pullus of two and a half smooth turns. Whorls five, excluding pullus, nearly flat, and slightly flattened at the anterior suture; sculptured with linear spiral grooves, and on the posterior whorls with transverse plications, which end posteriorly in granular crenatures. Last whorl somewhat ventricose behind, spirally lirate but the costae are obsolete, or reduced to mere crenulations at the suture. Base rapidly attenuated in a short narrow beak. Outer lip thin, smooth within; columella with four distant plaits." (Original description).

The species has not been reported on since its original description, and actual specimens could not be examined.

The holotype is presumably in the Tate Museum collection at the University of Adelaide, South Australia; the given dimensions are length 11.0mm, width 4.5mm, height of aperture 6.5mm.

? *Microvoluta atypha* (Tate, 1889)

1889. *Mitra atypha* Tate, Trans. Roy. Soc. Sth. Australia, 11: 138, pl. 4, fig. 6.

TYPE LOCALITY: Upper beds at Muddy Creek (Pliocene of Victoria).

"Shell stout, narrow-ovate, blunt at each end, whorls six, smooth, slightly convex. Aperture oval, outer lip lirate within, columella with four approximate plaits." (Original description).

The diagnosis is very short, and the specimen on which the description was based appears fractured, worn and has lost part of the siphonal canal. No mention has been made of this species in recent faunal lists, and the identity of this species remains obscure.

The holotype is presumably in the Tate Museum collection at the University of Adelaide, South Australia; the given dimensions are length 10.0mm, width 4.5mm, height of aperture 5.5mm.

Microvoluta teretiuscula (Thiele, 1925)

(Plate 15, fig. 8)

1925. *Mitra teretiuscula* Thiele, Wiss. Ergeb. Deut. Tief. Exp. Valdivia, 17 (2): 185, pl. 20, fig. 23.

TYPE LOCALITY: Station 104, Agulhas Bank, Lat. 35° 16′ S and Long. 22° 26.7′ E, in 155 metres (85 fathoms), South Africa.

Shell small, *c.* 8.0mm in length, elongate ovate, yellowish in colour, ornamented with wavy brown axial flames, zigzag lines and spiral bands. Teleoconch of 5 prominently convex whorls, protoconch of *c.* 1¼ white, large and globose nuclear whorls. Sculptured with an impressed spiral thread at the sutures, fine spiral striae and "S"-shaped growth striae. Aperture narrow, smooth within, labial lip thin and simple; columella with 4 weak folds, siphonal canal slightly recurved towards the aperture, siphonal notch absent.

The species is rather similar to *Microvoluta australis,* and has the typical globose protoconch, and a recurved and unnotched siphonal canal of *Microvoluta.*

The holotype of *M.teretiuscula* is in the Zoological Museum, Berlin; the given dimensions are length 8.0mm, width 3.0mm.

Microvoluta intermedia Dall, 1890

(Plate 15, figs. 6 - 7)

1890. *Conomitra intermedia* Dall, Proc. U.S. Nat. Mus., 12: 316, pl. 5, fig. 3.
1891. *Mitra miranda* E. A. Smith, Proc. Zool. Soc. London, p. 440, pl. 34, fig. 12.

TYPE LOCALITY: Off St. Bartholomew, West Indies, in 496 fathoms (908 metres), in sand, at 44.4°F (7°C) [= St. Barthelémy, Guadaloupe] (*intermedia*); Station 164B, off Sydney, in 410 fathoms (750 metres) [error !] (*miranda*).

Shell small, 6 - 15mm, elongate ovate to fusiformly ovate, width 38 - 48% of length; uniformly dirty white in colour. Teleoconch of 6 angulate whorls, protoconch of 1½ large and globose nuclear whorls. Sculptured with irregular, thin axial ribs, *c.* 8 on the body whorl, 10 - 20 on the penultimate whorl; axial ribs prominent on early whorls but tending to become obsolete on the ultimate two whorls, particularly on the lower half of the body whorl. Fine spiral striae encircle the shell, and may be faint in some specimens. Aperture narrow, about equal in height to the spire, constricted towards the base and smooth within; the labial lip thin and simple, the columella with 4 irregular, thin and distant folds, and the base of the shell spirally striate. The siphonal canal recurved towards the aperture in some specimens, siphonal notch absent.

In his description of new species from "Challenger" material, E. A. Smith (1891) remarked that among specimens dredged at Station 164B, there were undoubtedly several Atlantic forms of molluscs. According to Smith (1894), the Rev. Boog Watson, who examined the gastropods from this station, likewise questioned the correctness of the locality from the presence of Atlantic forms in the dredged haul, but Dr. Murray was convinced that no error in locality could possibly exist. Hedley (1901) dealt with the problem at length, and speculated that Station "164B" might be a mistaken label for "64", which would place the locality in the Atlantic, between Bermuda and the Azores. Hedley (*loc. cit.*) further commented on the presence of species endemic to the Atlantic in the *Sydney* dredge haul, and suggested an elimination of the species from Station 164B, from the Australian fauna.

I have examined the syntypes of *Mitra miranda* E. A. Smith and the holotype of *Conomitra intermedia* Dall, and find the two conspecific. The syntype series of *Mitra miranda* in the British Museum (Nat. Hist.) No. 1889.10.12.17-24, consists of 8 specimens mounted on two cards; the types range in size from 6.1mm - 9.4mm. The specimens are mostly young shells and are dull grey in colour. The occurrence of another Atlantic species in the *Sydney* dredge haul lends further support to an Atlantic locality origin of Station 164B.

The holotype of *Microvoluta intermedia* is in the United States National Museum, Washington, No. USNM 97102; the dimensions are length 15.0mm, width 5.7mm, height of aperture 7.5mm.

Smith (1891) did not associate *Mitra miranda* with the Volutomitridae, but remarked on the peculiar arrangement of the columellar folds, being far apart and not sloping in the same direction. Dall (1890) considered the large bulbous nucleus to be characteristic of deep water species.

Microvoluta joloensis Cernohorsky, 1970

(Plate 15, figs. 10 - 12)

1970. *Microvoluta joloensis* Cernohorsky, The Nautilus, 83: 103, figs. 8 - 10, 12.

TYPE LOCALITY: Station 5423, off Cagayan Island, Jolo Sea, Philippine Islands, in 508 fathoms (930 metres), grey mud and compact sand, at 49.8°F (10°C).

DISTRIBUTION: Off Cagayan I., Jolo Sea, Philippine Islands, 340 - 508 fathoms (622 - 930 metres), at 49.4° - 50.4°F (*c.* 10°C); Iligan Bay, Nth. Mindanao, Philippine Islands, 445 - 505 fathoms (814 - 924 metres), at 52.8°F (11.5°C); off Balicasag I., Sth. Bohol, Philippine Islands, 441 fathoms (807 metres), at 53°F (12°C); off Apo I., Sth. Negros, Philippine Islands, 256 fathoms (468 metres).

Shell small, 4 - 11mm, fusiformly elongate or fusiformly ovate, width 34 - 43% of length; off white, cream or fawn in colour, occasionally with a brown band on body whorl and a white band at sutures. Teleoconch of 5 - 7 moderately flat-sided to slightly convex whorls, protoconch of 1½ - 2 smooth and globose nuclear whorls. Sculptured with prominent, angulate and arcuate axial ribs, fine spiral striae and an impressed sutural girdle; axial ribs numbering 0 - 17 on the body whorl, 0 - 18 on the penultimate whorl; axials often obsolete on the last three whorls. Aperture narrow, equal in height or shorter than the spire, 42 - 52% of total length, smooth or lirate within; labial lip thin and simple, constricted anteriorly. Columella with 4 - 5 irregular, thin and distant folds, first posterior fold generally shorter than the second fold, siphonal notch absent, siphonal canal recurved towards aperture.

The 51 specimens examined showed a considerable amount of variation in form, sculpture, interior of aperture and columellar folds. Thirty-eight specimens had a smooth labrum, while 13 specimens were prominently lirate within the aperture. The labral lirations are a sporadic development in the *Microvoluta-Conomitra* group of species, and have no connection with habitat or the developmental stage of the species. From 10 specimens from Iligan Bay, 7 were lirate within the aperture and 3 specimens were smooth; in 7 specimens from Balicasag Island, only 2 specimens had a lirate labrum and 5 were smooth within the aperture. The impressed sutural thread was prominent in most specimens, but obscure in others, including the holotype.

The holotype is in the U.S. National Museum, Washington, No. USNM 288396; the dimensions are length 9.5mm, width 3.4mm, height of aperture 4.6mm.

Microvoluta royana Iredale, 1924

(Plate 15, fig. 13)

1924. *Microvoluta royana* Iredale, Proc. Linn. Soc. N.S.W., 49 (3): 269, pl. 35, fig. 13.
1951. *Mitra jervisensis* Laseron, Rec. Austral. Mus., 22 (4): 341, fig. 4.
1961. *Microvoluta royana* Iredale, Garrard, J. Malac. Soc. Australia, No. 5: 21.
1962. *Microvoluta royana* Iredale, Macpherson & Gabriel, Mar. Moll. Victoria, p. 223.
1966. *Microvoluta royana* Iredale, Garrard, J. Malac. Soc. Australia, No. 10: 5.

TYPE LOCALITY: Off Green Cape, N.S.W., Australia, in 50 - 70 fathoms (92 - 128 metres) (*royana*); Jervis Bay, N.S.W., in 15 fathoms (27 metres) (*jervisensis*).

DISTRIBUTION: East of Botany Bay, 50 fathoms (92 metres); Port Hacking; off Bateman's Bay, 25 fathoms (46 metres); Twofold Bay, 20 - 25 fathoms (37 - 46 metres) (all N.S.W.); 15 miles (24km) S.E. of Lakes Entrance, Victoria, 25 fathoms (46 metres); off Cape Moreton, Qld., 64 fathoms (117 metres).

Shell small, 8 - 11mm, slender, elongate ovate, width *c.* 38 - 40% of length; whitish to fawn in colour, ornamented with irregular zigzag streaks and brown blotches, base of columella dark brown. Teleoconch of 6 convex whorls, protoconch of 1½ smooth, glassy and globose nuclear whorls. Sculptured with fine spiral grooves which become spiral threads towards the base, 6 - 7 on the penultimate whorl, 20 - 25 on the body whorl; axial sculpture consists of growth striae or sometimes ill defined axial ribs, which number *c.* 17 on the body whorl and 23 on the penultimate whorl in the type. Aperture is narrow, shorter than the spire, *c.* 44 - 46% of total length, smooth within; labial lip is thin and simple, constricted anteriorly. Columella with 4 irregular, thin and distant folds, posterior fold shorter than the second fold, siphonal canal recurved towards aperture, siphonal notch absent.

Microvoluta royana is similar to *M.australis,* but differs in features of shorter aperture, more prominent spiral and axial sculpture and a more irregular outline of the body whorl; the purple brown stain at the base of the columella is common to both species. Contrary to Iredale (1924), the spiral sculpture in *M.australis* is not always confined to the sutures, but may extend from the suture to the base in some specimens.

The holotype of *Microvoluta royana* is in the Australian Museum, Sydney, No. C-67279; the dimensions are length 9.9mm, width 4.0mm, height of aperture 4.5mm. Iredale cited "Twofold Bay" as the first locality, but since the holotype originated from Green Cape, N.S.W., the latter locality must be accepted as the type locality.

In *Microvoluta jervisensis* the spiral sculpture is as prominent as in *M.royana,* but the axial riblets are obsolete and replaced by axial growth striae; the sutures have an impressed spiral thread. The holotype of *M.jervisensis* is in the Australian Museum, Sydney; the dimensions are length 11.0mm, width 4.2mm, height of aperture 5.0mm. For details, see Garrard (1966).

Microvoluta marginata (Hutton, 1885)

(Plate 15, figs. 14 - 19 and Plate 16, figs. 1 - 2)

1885. *Turricula marginata* Hutton, Trans. N.Z. Inst., 17: 315, pl. 18, fig. 4 (non *Vulpecula marginata* Suter, 1908).
1885. *Turricula lincta* Hutton, Trans. N.Z. Inst., 17: 326.
1906. *Vulpecula(Pusia)biconica* Murdoch & Suter, Trans. N.Z. Inst., 38: 289, pl. 23, fig. 22.

1913. *Vexillum marginatum* (Hutton), Suter, Man. N.Z. Moll., p. 363; 1915, Atlas, pl. 18, fig. 4 (with *Vulpecula(Pusia) biconica* Murdoch & Suter in synonymy).

1915. *Vexillum linctum* (Hutton), Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 3: 21, pl. 8, fig. 8.

1930. *Microvoluta cuvierensis* Finlay, Trans. N.Z. Inst., 61: 242, pl. 43, figs. 19, 21.

1930. *Microvoluta biconica* (Murdoch & Suter), Finlay, Trans. N.Z. Inst., 61: 242, pl. 43, figs. 13, 15.

TYPE LOCALITY: Wanganui (Terangian), Upper Pleistocene of New Zealand (*marginata*); Petane (Nukumaruan), Lower Pleistocene of New Zealand (*lincta*); Cuvier Island, east of Gt. Barrier Island, in 110 fathoms (201 metres) (*biconica*); off Cuvier Island, in 38 fathoms (70 metres) (*cuvierensis*).

DISTRIBUTION: Petane, Hawkes Bay (Nukumaruan), L. Pleistocene; Castlecliff, Wanganui (Castlecliffian), Mid-Pleistocene; off Three Kings Island, 260 metres (142 fathoms); near North Cape, 11 - 20 fathoms (20 - 37 metres); off Ahipara, 23 fathoms (42 metres); Taupo Bay, Whangaroa; between Waewaetorea I. and Motukiekie I., Bay of Islands, sandy bottom, 8 fathoms (15 metres); off Poor Knights Islands, 60 fathoms (110 metres); E.N.E. of Poor Knights Islands, 180 - 240 fathoms (329-439 metres); Hen & Chicken Islands, 25 - 35 fathoms (46 - 64 metres); off Gt. Barrier Island, 110 fathoms (201 metres); off Cuvier Island, 35 - 40 fathoms (64 - 73 metres); off Aldermen Island, 200-300 fathoms (366 - 549 metres); off Oamaru, Sth. Island, 50 fathoms (92 metres); Resolution Island, Five Fingers Peninsula, Sth. Island, *c.* 70 fathoms (128 metres); Snares Island, 50 fathoms (92 metres); 21 miles (33.6km) N.E. of Wreck reef, Stewart Island, 50 - 54 fathoms (92 - 99 metres); Port Pegasus, Stewart Island, 18 fathoms (33 metres) (last two records from Suter, 1913).

Shell small, 5 - 8mm, ovate to elongate ovate, width 43 - 54% of length, off white in colour, ornamented with irregular reddish-brown blotches, axial flames or spiral bands, base of columella purplish-brown. Teleoconch of 4 - 5½ medially angulate whorls, protoconch of 1½ smooth and globose nuclear whorls. Sculptured with coarse axial ribs which form nodes on the presutural ramp, ribs either distinct or obsolete on the body whorl; spiral threads and sutural girdle either prominent or obsolete. Aperture narrow, shorter or longer than the spire, 44 - 61% of total length, smooth or lirate within; labial lip thin and simple, contracted anteriorly. Columella with 4, rarely 3 or 5, thin and irregular folds; siphonal canal recurved towards aperture, siphonal canal spout-shaped, siphonal notch absent. Animal and operculum unknown.

Microvoluta marginata is very variable in both form and sculpture. One hundred and thirty-three specimens of the various "species" were examined, and diagnostic characters on which these "species" were based proved to be as variable and intergrading as in other species of *Microvoluta*. The spiral sculpture may consist of either grooves or threads, which may be confined to the sutures or prominently developed over the whole length of the body whorl; the sutural girdle is prominent in some specimens and absent in others. Out of 133 specimens examined, 7 specimens had 5 columellar folds, and 3 specimens 3 folds only; only 14 specimens had labral lirae, 2 Pleistocene specimens included. Individuals with a lirate labrum appear to be more frequent at depths from 180 - 300 fathoms (329 - 549 metres) (85% of specimens are lirate on labrum), whereas specimens collected at depths from 8 - 50 fathoms (15 - 92 metres) are rarely lirate within the aperture.

Hutton's earliest name for the small New Zealand *Microvoluta* has been ignored by recent authors, and has been generally substituted with taxa proposed for Recent species. *Turricula marginata* Hutton, is not a secondary homonym of *Mitra marginata* Lamarck, 1803, *M.marginata* Sowerby, 1874 or *Thala marginata* Tenison-Woods, 1877. Suter (1908), erroneously applied Hutton's *Turricula marginata* to an *Austromitra* species. The lectotype of *Microvoluta marginata* is in the Canterbury Museum, Christchurch, No. M-3149; the dimensions are length 6.1mm, width 2.8mm, height of aperture 3.5mm. The type is the same form which has been described subsequently as *Vulpecula biconica* Murdoch & Suter. The lectotype of *Microvoluta marginata* is immature, and has 7 nodulose axial ribs on the body whorl and 13 on the penultimate whorl; on the body whorl, the axial ribs are more or less confined to the presutural ramp. Spiral striae number 3 on the penultimate whorl and 15 on the body whorl; the sutural girdle is distinct on all whorls, but becomes obsolete on the ultimate whorl. The aperture is smooth within and the columella has 4 folds. The paralectotype No. M-3150: length 7.4mm, width 3.0mm, height of aperture 3.0mm, is the slender form of the species, larger and more mature than the lectotype, and with fewer but more prominent spiral striae.

The holotype of *Turricula lincta* Hutton, is in the Canterbury Museum, Christchurch, No. M-3386; the dimensions are length 4.7mm, width 2.5mm, height of aperture 2.4mm. The type is a juvenile specimen of *Microvoluta marginata,* with only 3½ mature whorls and 1½ nuclear whorls. There are

7 nodulose axial ribs on the body whorl and 13 on the penultimate whorl. The spiral striae at this stage of development are still obscure and ill developed, apart from *c.* 8 striae on the lower half of the body whorl.

The type of *Vulpecula(Pusia)biconica* Murdoch & Suter, is in the Dominion Museum, Wellington; the given dimensions are length 5.0mm, width 2.8mm, height of aperture 2.5mm. Three paratypes, No.'s TM-1060 - 1062, are in the N.Z. Geological Survey collection, Lower Hutt. *Microvoluta biconica* is the broad form of *M.marginata*, and Suter (1913) relegated the species, which he co-authored, to the synonymy of *M.marginata*.

The holotype and 14 paratypes of *Microvoluta cuvierensis* Finlay, are in the Auckland Institute & Museum, Auckland. The holotype No. TM-473: length 6.2mm, width 2.7mm, height of aperture 3.4mm, is the slender form of *M.marginata*. The sutures have an impressed girdle, the body whorl has 5 axial ribs, and the penultimate whorl 12; the paratypes are variable in form and sculpture.

Microvoluta vetusta Laws, 1936

(Plate 16, fig. 3)

1936. *Microvoluta vetusta* Laws, Trans. Roy. Soc. N.Z., 66: 118, pl. 17, fig. 74.

TYPE LOCALITY: Kaawa Creek, Port Waikato (Opoitian), Lower Pliocene of New Zealand.

Only the holotype of *M.vetusta* has been examined, and this particular specimen scarcely differs from *M.marginata* (Hutton). The aperture is lirate within, and 14 specimens of *M.marginata* examined also had a lirate labrum. The axial nodes are not as spinose as they may appear in the original figure, and the type is comparable to the specimen of *M.marginata* illustrated on Plate 16, fig. 1.

The holotype is in the Department of Geology, Auckland University, Auckland, No. G-5844; the dimensions are length 8.4mm, width 4.0mm, height of aperture 3.9mm.

Microvoluta hottentota (Thiele, 1925)

(Plate 15, fig. 9)

1925. *Turricula hottentota* Thiele, Wiss. Ergeb. Deut. Tief. Exp. Valdivia, 17 (2): 186, pl. 20, fig. 24.
1932. *Xancus* sp. ? Turton, Mar. shells Pt. Alfred, p. 45, pl. 10, fig. 333.

TYPE LOCALITY: Station 104, Agulhas Bank, Lat. 35° 16′ S and Long. 22° 26.7′ E, South Africa, in 155 metres (85 fathoms).

Shell small, 7 - 8mm, elongate ovate, yellowish in colour; teleoconch of 4 convex whorls, protoconch of 1½ smooth, globose nuclear whorls. Sculptured with regular, thin axial ribs and numerous fine spiral striae. Aperture slightly longer than the spire, labial lip thin and simple, and the labrum lirate: columella with 4 folds, posterior fold shorter than the second fold, siphonal notch absent.

Thiele (1925) based his description on 2 shells, one of which was lirate within the aperture. The specimen figured by Turton (1932) as *Xancus* species appears to be a young specimen (3.5mm x 2.0mm) of *Microvoluta hottentota*.

The holotype of *Microvoluta hottentota* is in the Zoological Museum, Berlin; the dimensions given by the author are length 7.5mm, width 3.1mm.

Microvoluta blakeana (Dall, 1889)

(Plate 16, fig. 4)

1889. *Conomitra blakeana* Dall, Bull. Mus. Comp. Zool. Harvard, 18: 163.
1889. *Conomitra blakeana* var. *laevior* Dall, Mus. Comp. Zool. Harvard, 18: 164, pl. 35, fig. 10.

TYPE LOCALITY: Yucatan Strait, Mexico, 640 fathoms (1171 metres) (*blakeana*); off Havana and Cape San Antonio, Cuba, in 80 - 300 fathoms (146 - 549 metres) (var. *laevior*).

DISTRIBUTION: Gulf of Mexico to Cuba and Yucatan Strait.

Shell small, 8 - 10mm, solid, elongate ovate, width 50 - 54% of length; purplish-brown, ornamented with large white blotches in less faded specimens, spire and base white in colour. Teleoconch of 4½ - 5 slightly convex whorls, protoconch of 1½ - 2 smooth, large and dome-shaped nuclear whorls. Sculptured with irregular and fine axial ribs which may become obsolete on the last 2 whorls; in the holotype of *M.blakeana,* the penultimate whorl with 21 obsolete axial ribs, the body whorl 31. In the smooth form *laevior,* the axial ribs confined to the early whorls. Aperture narrow, longer than the spire, width 62 - 68% of total length, smooth within; labial lip thickened and simple. Columella with 5 folds, posterior fold slightly shorter than the second fold. Siphonal canal with *c.* 6 oblique cords, siphonal notch absent.

The holotype of *Microvoluta blakeana* is in the U.S. National Museum, Washington, No. USNM 86968; the dimensions are length 8.0mm, width 4.3mm, height of aperture 5.4mm. The holotype of the var. *laevior* is in the same Institution, No. USNM 86969; the dimensions are length 9.3mm, width 4.8mm, height of aperture 5.8mm.

Genus Waimatea Finlay, 1927

Waimatea Finlay, 1927, Trans N.Z. Inst., 57: 408. Type species by OD *Mitra inconspicua* Hutton, 1885. Upper Eocene of New Zealand. (First reviser Preston, 1928, p. 70).

= 1927. *Waimatea* Allan, Trans. N.Z. Inst., 57: 289 (type species by M *W.inconspicua* Hutton).

= 1927. *Waimatea* Finlay, Trans. N.Z. Inst., 57: 408.

1942. *Compsomitra* Marwick, Trans. Roy. Soc. N.Z., 72: 278 (Type species by OD *C.incisa* Marwick, 1942. Mid-Eocene of New Zealand).

Shell small, 7 - 22mm, fusiformly elongate to fusiformly ovate; teleoconch of 5 - 6½ convex whorls, protoconch of 1½ - 2½ smooth, globose nuclear whorls. Smooth, or axially costate and spirally striate, axial ribs frequently obsolete on the last 1 - 2 whorls where they are replaced by growth striae. Aperture moderately narrow, equal in height to or longer than the spire, smooth within; labial lip thin and simple, angulate or crescent-shaped. Columella with 4 thin and distant folds, first posterior fold generally shorter than the second fold; siphonal canal straight, siphonal notch feeble or absent.

The radula of the only living *Waimatea* species (Fig. 189), is volutomitrid. The rachidian is similar to both *Volutomitra* and *Microvoluta*; the single cusp is slender and moderately long, and no laterals were recovered from the odontophore. The operculum is very small, irregularly ovate, brown in colour and with an indistinct nucleus.

Species of the *Waimatea* group are restricted to the Austral-Neozelanic region. The genus *Waimatea* s.str. contains 10 fossil and 1 Recent species. The type species *Waimatea inconspicua* (Hutton), resembles the European Paleocene-Oligocene mitrid genus *Dentimitra,* but differs in features of protoconch, siphonal notch and columellar folds.

Geographical distribution: Australia and New Zealand. Lat. 34° - 42° S (Recent).

Stratigraphical range: M. Eocene — Recent.

Habitat: On gravel and sand substratum, and under rocks intertidally; from 0 - 36 metres (0 - 20 fathoms).

Waimatea inconspicua (Hutton, 1885)

(Plate 16, figs. 5 - 6)

1885. *Mitra inconspicua* Hutton, Trans. N.Z. Inst., 17: 326.
1915. *Mitra inconspicua* Hutton, Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 3: 20, pl. 4, fig. 7.
1917. *Vexillum apicicostatum* Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 5: 27, pl. 12, fig. 5.
1924. *Conomitra inconspicua* (Hutton), Finlay, Trans. N.Z. Inst., 55: 468, pl. 50, figs. 2a, b.
1926. *Conomitra inconspicua* (Hutton), Allan, Trans. N.Z. Inst., 56: 341, pl. 77, figs. 1a, b.
1926. *Conomitra apicicostata* (Suter), Allan, Trans. N.Z. Inst., 56: 341.
1927. *Waimatea inconspicua* (Hutton), Finlay, Trans. N.Z. Inst., 57: 408.
1930. *Waimatea inconspicua* var. (Hutton), Finlay, Trans. N.Z. Inst., 61: 66, pl. 5, fig. 66.

Type locality: Mount Harris (error ! — see Finlay, 1927) and Waihao greensands (Kaiatan, Upper Eocene of New Zealand) (*inconspicua*); Marly greensands, Waihao River, Sth. Canterbury (Bortonian, Mid-Eocene of New Zealand) (*apicicostata*).

DISTRIBUTION: McCullough's bridge and Waihao Downs, Sth. Canterbury (Mid-Upper Eocene).

Shell moderately small, 9 - 20mm, fusiformly ovate, width 37 - 51% of length; teleoconch of 5½ - 6½ convex whorls, protoconch of 1½ - 2 smooth and globose nuclear whorls. Variable in sculpture, generally smooth with only axial growth striae and obsolete spirals; some specimens have irregular, thin axial ribs which extend as far as the penultimate whorl. The penultimate whorl with 0 - 6 spirals, the body whorl up to 5 spirals near the sutures and up to 10 spiral threads at base of body whorl. Aperture narrow, longer than the spire, 59 - 67% of total length, smooth within; the labial lip thin and simple, angulate near the juncture of the aperture, constricted anteriorly. Columella with 4 thin and distant folds, first posterior fold generally shorter than second fold, siphonal notch absent.

From the 75 specimens examined, only one specimen had 5 columellar folds. In one specimen, the thin axial threads almost reached the aperture. Several specimens of *Waimatea inconspicua* from McCullough's bridge could easily be matched with the type of *W.apicicostata*. Finlay's figure of *W. apicicostata* (1930, pl. 5, fig. 74), appears to be a juvenile specimen of *Conomitra plicatella* (Marshall & Murdoch).

The holotype of *Waimatea inconspicua* is in the Canterbury Museum, Christchurch; the given dimensions are length 17.0mm, width 7.5mm.

The holotype of *W.apicicostata* is in the N.Z. Geological Survey collection, Lower Hutt; the dimensions are length 11.6mm, width 5.2mm, height of aperture 7.6mm. The type is an immature shell with a large portion of the labial lip and body whorl missing. The early whorls are axially plicate, but the riblets become obsolete on the last two whorls and persist only as thin axial threads and growth striae. The early whorls are also spirally striate, and the siphonal fasciole has *c.* 6 spiral threads.

Waimatea amplexa Finlay, 1930

(Plate 16, fig. 7)

1930. *Waimatea amplexa* Finlay, Trans. N.Z. Inst., 61: 66.
1966. *Waimatea amplexa* Finlay, Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: Waihao Downs greensands, on the bank of the Waihao River, Sth. Canterbury (Bortonian, Mid-Eocene of New Zealand).

DISTRIBUTION: Abandoned railway cutting, Waihao Downs (Bortonian), M. Eocene of New Zealand.

The species is rather similar to *Waimatea inconspicua* (Hutton), but is smaller, 8 - 10mm in length, more slender, width 38 - 43% of length, and the aperture is generally shorter, 52 - 59% of total length; it is similar in sculpture to *W.inconspicua*. In the type specimens, the whorls are regularly convex and clasping the sutures and not staged on the presutural ramp as in *W.inconspicua*, however, in some small specimens of *W.inconspicua*, the whorls join the sutures in a similar manner as in *W.amplexa*.

The species is easily confused with small specimens of *W.inconspicua* which do not exhibit the small horizontal presutural ramp, and some doubt exists whether *W.amplexa* is really specifically separable from *W.inconspicua*; the aperture seems to be constantly shorter in the few type specimens of *W.amplexa* examined, than in *W.inconspicua*.

The holotype and 6 paratypes of *Waimatea amplexa* are in the Auckland Institute & Museum, Auckland, No. TM-846; the dimensions of the holotype are length 10.3mm, width 3.9mm, height of aperture 5.9mm.

Waimatea parki (Allan, 1926)

(Plate 16, figs. 8 - 9)

1926. *Vexillum parki* Allan, Trans. N.Z. Inst., 56: 341, pl. 77, fig. 2.
1966. *Proximitra parki* (Allan), Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: McCullough's Bridge, Waihao (Kaiatan), Upper Eocene of New Zealand.

Shell moderately small, 9 - 15mm, fusiformly ovate, width 36 - 44% of length; teleoconch of 5 - 6 convex or angulate whorls, protoconch of 1½ smooth and globose nuclear whorls. Sculpture variable, early whorls axially ribbed and all whorls spirally striate; the spiral striae are weak or

prominent, 4 - 7 on the penultimate whorl, 10 - 30 on the body whorl. The penultimate and body whorl generally lack longitudinal sculpture, but some specimens with 12 - 14 axial ribs on each whorl. Whorls either moderately convex or angulate at the periphery, and the presutural ramp either smooth and sweeping concavely to the suture, or spirally striate and flat to slightly convex. The aperture narrow, equal in height to or slightly longer than the spire, 52 - 58% of total length, smooth within; columella with 4 distant folds.

The holotype of *Waimatea parki* appears to have been lost, but 5 paratypes are in the Auckland Institute & Museum, Auckland; the largest specimen measures length 12.0mm, width 4.9mm, height of aperture 6.5mm, and the smallest specimen length 9.6mm, width 3.5mm, height of aperture 5.1mm.

Waimatea incisa (Marwick, 1942)

(Plate 16, fig. 10)

1942. *Compsomitra incisa* Marwick, Trans. Roy. Soc. N.Z., 72: 278, pl. 25, fig. 29.
1966. *Compsomitra incisa* Marwick, Fleming, N.Z. Geol. Surv. Bull., No. 173: 64, pl. 113, fig. 1372.

TYPE LOCALITY: Hampden Beach, N.E. Otago, Bortonian stage, Mid-Eocene of New Zealand.

Shell rather small, *c.* 16.0mm in length, fusiform, spire higher than aperture; protoconch of about 2 whorls with a large bulbous apex. Sculpture of numerous strongly arched axial ribs, about 21 per whorl; the whole surface bears regular spiral grooves, separating flat cords which number 10 on the penultimate whorl. Aperture smooth within, portion of labial lip missing on the type but presumably simple, columella with 4 folds (compounded original description).

In form, protoconch and features of produced siphonal canal, this species resembles *Waimatea inconspicua* (Hutton). In the latter species the axial ribs are obsolete on the last 2 whorls, and less prominent and angulate than in *W.incisa*; the latter is also prominently striate on the body whorl. *Waimatea parki* is also axially costate and striate, but the axial ribs are less numerous and regular and farther apart, while the presutural ramp of *W.parki* is lacking in *W.incisa*.

The holotype of *Waimatea incisa* is in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 16.0mm, width 6.5mm.

Waimatea obscura (Hutton, 1873)

(Plate 16, figs. 11 - 14)

1845. *Mitra pica* Reeve, Conch. Icon., pl. 31, sp. 247 (non Deshayes & M. Edwards, 1844).
1873. *Mitra obscura* Hutton, Cat. Mar. Moll. N.Z., p. 19.
1874. *Mitra pica* Reeve, Sowerby, Thes. Conchyl., 4: 25, pl. 23, fig. 522 ("Cape of Good Hope"—error !).
1878. *Mitra obscura* Hutton, J. Conchyl., 18: 21.
1880. *Mitra obscura* Hutton, Man. N.Z. Moll., p. 60.
1882. *Mitra pica* Reeve, Tryon, Man. Conch., 4: 125, pl. 37, fig. 96.
1897. *Mitra obscura* Hutton, Suter, Proc. Malac. Soc. Lond., 2 (5): 201, textfig. (figd. holotype).
1898. *Mitra albopicta* E. A. Smith, Proc. Malac. Soc. Lond., 3 (1): 21, textfig. 5 (smooth form).
1913. *Mitra albopicta* E. A. Smith, Suter, Man. N.Z. Moll., p. 360; 1915, Atlas, pl. 46, fig. 9.
1913. *Vexillum obscurum* Hutton, Suter, Man. N.Z. Moll., p. 365; 1915, Atlas, pl. 46, fig. 11.
1923. *Mitra pica* Reeve, May, Ill. Ind. Tasman. shells, p. 79, pl. 37, fig. 12.
1924. *Mitra mortenseni* Odhner, Vid. Medd. Dansk nat. For., 77: 34, pl. 1, fig. 24.
1927. *Mitra albopicta* Smith, Finlay, Trans. N.Z. Inst., 57: 408 (= *M.obscura*).
1932. *Proximitra pica* Reeve, Cotton & Godfrey, Sth. Austral. Nat., 13 (2): 81, pl. 4, fig. 5.
1962. *Proximitra pica* (Reeve), Macpherson & Gabriel, Mar. Moll. Victoria, p. 215, fig. 256.

TYPE LOCALITY: No locality given for *Mitra pica* Reeve; Bay of Islands, New Zealand (*obscura*); Mokohinau Island, N.Z. (*albopicta*); North Cape, Nth. coast, New Zealand (*mortenseni*).

DISTRIBUTION: Australia: Western Port; Otway coast; Warrnambool; Lorne; Port Fairy (all Victoria); Port McDonnell; Port Elliot; Kangaroo Island; Spencer Gulf; Flinders Island (all Sth. Australia); King Island, Bass Strait; Kelso; Port Arthur, Tasmania. New Zealand: Cape Maria van Diemen; Whangaroa Bay, 15 fathoms (27 metres); Cavalli Island; Matauri Bay; Waiwaitoria I., Bay of Islands, 12 - 13 fathoms (22 - 24 metres); Poor Knights Islands, 5 - 20 fathoms (9 - 22 metres); Nth.

off Tutukaka beach; Chicken Island; Tuhua reef, Mayor Island, 35 fathoms (64 metres), ex-pisces; Tauranga Bay, intertidal; Waihau Bay, Cape Runaway; Cape Palliser, Cook Strait (questionable record ex-Webster collection).

Shell moderately small, 10 - 22mm, ventricose and ovate, width 44 - 55% of length; variable in colour, generally blackish-brown, brown or olive, ornamented with a broad white zone at the sutures and siphonal canal; the dark coloured area may be profusely spotted with white, while the white sutural zone is occasionally flecked with orange-brown. Teleoconch of 5 - 6 convex whorls, whorls occasionally subangulate, protoconch of 1½ smooth and globose nuclear whorls. Sculpture consists of axial ribs and spiral striae, but axial sculpture is often confined to the early postnuclear whorls; axial ribs 0 - 21 on the penultimate and body whorl. Spiral striae 2 - 8 on the penultimate whorl, 2 - 5 at the suture of the body whorl with additional 10 - 20 striae on the lower half of the body whorl. The grooves generally in the form of incised spiral lines, but cord-like in some immature specimens. The aperture moderately wide, longer than the spire, 57 - 75% of total length, greenish-brown and smooth within; the labial lip angulate, almost perpendicular before contracting to the siphonal canal. Columella with 4 distant folds, first posterior fold generally shorter than the second; siphonal canal straight or slightly recurved, siphonal notch very feeble or absent. Periostracum thin and brown in colour.

The operculum is very small, *c.* 2mm long, thin and light brown in colour; the muscular attachment ledge is circular. The penis is small, more or less banana-shaped and smooth.

The odontophore is white in colour, very narrow and moderately long. Rachidians have a slender and moderately long curved cusp, and the side flanges of the base plate are broader than in either *Microvoluta* or *Volutomitra;* no lateral teeth have been recovered.

The sole of the foot, head and siphon of the animal are translucent white, ornamented with elongated yellow spots; the central part of the sole of the foot is streaked with dark brown, and the eyes are small, black and elliptical and the tentacles are short and stubby.

Mitra pica Reeve, described from unknown locality, is the earliest description of the species, but Reeve's taxon is a primary homonym of *Mitra pica* Deshayes & M. Edwards, 1844, which is a substitute name proposed for *Voluta pica* Dillwyn, 1817 and "Chemnitz", 1795. Angas (1878) was the first author who reported the species from Australia, although some writers (Sowerby, 1874 and Tryon, 1882) recorded the species from South Africa. Reeve's 3 syntypes of *Mitra pica* are in the British Museum (Nat. Hist.), London, ex-Cuming collection, No. BMNH 1967838; the length of the 3 syntypes are 17.2mm, 15.2mm and 14.8mm. The largest specimen, length 17.2mm, width 7.8mm, height of aperture 10.8mm, is here selected as the lectotype of *Mitra pica* Reeve, and it is the same specimen figured by Reeve on plate 31, sp. 247.

Mitra albopicta E. A. Smith, has been separated from *M.pica* on features of larger size and different colouring. The lectotype of *M.albopicta* is in the N.Z. Geological Survey collection, Lower Hutt, No. TM-919; the given dimensions are length 21.5mm, width 9.5mm.

Mitra mortenseni Odhner, has been based on an axially ribbed specimen with 14 axial ribs on the body whorl. The axially costate specimens are ecophenotypic variants which occur sporadically in all populations of *Waimatea obscura;* the axial ribbing on the last two whorls is generally more prevalent in immature specimens, and the spiral sculpture is also more prominent in young shells. The holotype of *M.mortenseni* is in the University Museum of Copenhagen; the given dimensions are length 14.4mm, width 7.3mm.

Waimatea conoidalis (Tate, 1889)

(Fig. 216)

1889. *Mitra conoidalis* Tate, 1889, Trans. Roy. Soc. Sth. Australia, 11: 144, pl. 10, figs. 2a, b.

TYPE LOCALITY: Lower beds at Muddy Creek (Balcombian), Mid-Miocene of Victoria, Australia.

Shell small, stout, biconic, with a short regularly conic spire, extending in a relatively large depressed pullus; ordinary spire whorls nearly flat, sloping more rapidly to the anterior suture, and slightly margined at the posterior suture; ornamented by slender costae and a few spiral engraved lines. Last whorl oblong, rather abruptly attenuated at the base, flatly rounded over

the suture; with a few revolving threads at the shoulder and at the base, the median portion transversely striate. Aperture narrow-elliptic; outer lip thin, smooth; columella with four plaits. (Original description).

The species has not been mentioned by Harris (1897), and no specimens were available for examination. The small size and depressed protoconch (which could be worn), would favour assignment to *Parvimitra*, but in form and sculpture the species shows affinities with *Waimatea* s.str., and the placement in the latter genus is only tentative.

The holotype of *Waimatea conoidalis* is presumably in the Tate Museum collection at the University of Adelaide, Sth. Australia; the given dimensions are length 7.0mm, width 3.5mm, height of aperture 5.5mm.

Fig. 216. *Waimatea conoidalis* (Tate, 1889). Lower beds at Muddy Creek, M. Miocene of Victoria, Australia (from Tate, 1889, pl. 10, figs. 2a, b — length 7.0mm).

Waimatea enavata (Marwick, 1931)

(Fig. 217)

1931. *Proximitra enavata* Marwick, N.Z. Geol. Surv. Paleont. Bull., No. 13: 123, pl. 13, fig. 243.
1966. *Proximitra enavata* Marwick, Fleming, N.Z. Geol. Surv. Bull., No. 173: 64, pl. 113, fig. 1375.

TYPE LOCALITY: Ormond series; 1325; Mangatarehu Stream, Gisborne District (Opoitian), Lower Pliocene of New Zealand.

The species is rather similar to the costate form of *Waimatea obscura* (Hutton). The whorls are subangulate and have 15 axial ribs on the early turns, and 18 on the body whorl; the penultimate whorl has 5 spiral striae and the body whorl 10 - 12. The distribution of the spiral striae is similar to *W.obscura*, some striae being confined to the suture and others to the base of the body whorl. The aperture is longer than the spire, smooth within; the labial lip has the angulate aspect of *W.obscura*. The columella has 4 distant folds, the posterior fold shorter than the second fold.

The holotype of *Waimatea enavata* is in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 19.0mm, width 9.2mm.

Fig. 217. *Waimatea enavata* (Marwick, 1931). Mangatarehu Stream, Gisborne District, L. Pliocene of New Zealand; length 19.0mm (from Marwick, 1931, pl. 13, fig. 243).

Waimatea costulosa (Marwick, 1965)

(Fig. 218)

1965. *Proximitra costulosa* Marwick, N.Z. Geol. Surv. Paleont. Bull., No. 39: 38, pl. 7, fig. 17; pl. 10, fig. 7.
1966. *Proximitra costulosa* Marwick, Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: Above 20 ft. bed of limestone, Ruakituri Road, Hangaroa Survey District, Wairaea, Hawke's Bay (Opoitian), Lower Pliocene of New Zealand.

Shell of moderate size, rather tumid, spire weakly gradate, about equal in height to aperture plus canal. Protoconch tholoid, slightly tilted of two smooth whorls with large nucleus. Early spire whorls strongly angled about middle but later whorls angled more adapically and with steeply sloping sutural ramp, body whorl regularly curved. About 20 low axials per whorl, well spaced and raised into tubercles at shoulder of early spire whorls, but weakening across sutural ramp, very weak on penultimate whorl, absent from body. Spiral sculpture of obsolete, close, spiral threads, strongest on base. Columella bearing three strong, well-spaced folds, a fourth very weak abapical one. (Original description).

The figured specimen is a dorsal view of a shattered but restored specimen, and the important ventral view has been omitted by the author. The species is similar to the Pliocene *Waimatea cnavata* from Gisborne and the Recent *W.obscura;* in the latter species, axials are generally obsolete or absent on the last whorl. In *W.costulosa,* the early whorls are said to be tubercled at the shoulder (not shown in Fig. 1), whereas in the costate form of *W.obscura* the axial ribs tend to be only granose at the sutures where they are bisected by the spiral threads. The aperture is equal in height to the spire in *W.costulosa,* but always longer than the spire in *W.obscura* and *W.cnavata.*

The holotype of *Waimatea costulosa* is in the N.Z. Geological Survey collection, Lower Hutt; No. TM-3747, together with paratype TM-3748; the given dimensions for the type are length 19.5mm, width 9.5mm.

Fig. 218. *Waimatea costulosa* (Marwick, 1965). Ruakituri Road, Hawke's Bay, L. Pliocene of New Zealand; length 19.5mm (from Marwick, 1965, pl. 7, fig. 17).

Waimatea enysi (Hutton, 1873)

(Plate 17, fig. 1)

1873. *Mitra enysi* Hutton, Cat. Tert. Moll. Echin. N.Z., p. 7.
1917. *Vexillum ligatum* Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 5: 28, pl. 4, fig. 9.
1924. *Vexillum suteri* Finlay, Proc. Malac. Soc. Lond., 16 (2): 102 (nom. subst. pro *V.ligatum* Suter, 1917).
1927. *Proximitra enysi* (Hutton), Finlay, Trans. N.Z. Inst., 57: 410.
1929. *Proximitra incisula* Marwick, Trans. N.Z. Inst., 59: 920, 934, fig. 67.
1930. *Proximitra incisula* Marwick, Finlay, Trans. N.Z. Inst., 61: 258.
1966. *Proximitra ligata* (Suter), Fleming, N.Z. Geol. Surv. Bull., No. 173: 64, pl. 113, fig. 1376.
1966. *Proximitra enysi* (Hutton), Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: Broken River (Duntroonian), Upper Oligocene of New Zealand (*enysi*); left bank of Waitaki River, opposite Wharekuri, Waitaki Valley (Duntroonian), U. Oligocene of N.Z. (*ligata*); Chatton (Duntroonian), U. Oligocene of N.Z. (*incisula*).

Shell moderately small, 9 - 20mm, fusiformly ovate, width 42 - 49% of length; protoconch of 5 - 6 subangulate, convex whorls, protoconch of 1½ - 2 smooth and globose nuclear whorls. Sculptured with coarse, angulate axial ribs, *c.* 11 - 18 on the penultimate whorl, 11 - 15 on the body whorl; spiral striae 12 - 25 on the body whorl, generally most prominent below the body whorl suture, where axial ribs tend to become more pronounced. The striae become obsolete in centre of body whorl and again more distinct towards base. The aperture equal in height or longer than the spire, narrow, smooth within; the labial lip simple. Columella with 4 distant folds, first posterior fold shorter than the second fold, siphonal canal straight.

Waimatea enysi (Hutton), has been rarely mentioned in New Zealand paleontological literature, and the species has never been illustrated. From the examination of the holotype of *W.enysi* it is clearly evident that the species is conspecific with *Vexillum ligatum* Suter and *Proximitra incisula* Marwick, from deposits of the same horizon. The holotype of *Waimatea enysi* is in the N.Z. Geological Survey collection, Lower Hutt; the dimensions are length 19.7mm, width 8.4mm, height of aperture 12.3mm.

The holotype of *Vexillum ligatum* Suter, is in the Otago University Museum, Dunedin; the given dimensions are length 9.0mm, width 4.0mm. The holotype of *Proximitra incisula* Marwick is in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 12.5mm, width 6.0mm.

Waimatea othone (Tenison-Woods, 1880)

(Plate 17, figs. 2 - 7)

1880. *Mitra othone* Tenison-Woods, Proc. Linn. Soc. N.S.W., 4: 8, pl. 2, fig. 4.
1889. *Mitra othone* Tenison-Woods, Tate, Trans. Roy. Soc. Sth. Australia, 11: 139, pl. 4, fig. 10.
1897. *Conomitra othone* Tenison-Woods, Harris, Cat. Tert. Moll. Brit. Mus., p. 129.
1924. *Conomitra othoniana* Finlay, Trans. N.Z. Inst., 55: 467, pl. 50, figs. 3a, b.
1930. *Waimatea transilis* Finlay, Trans. N.Z. Inst., 61: 67.

TYPE LOCALITY: Muddy Creek, Miocene of Victoria, Australia (*othone*); Target Gully, Oamaru, Otago (Awamoan), Lower Miocene of New Zealand (*othoniana*): Otiake, sandy beds above limestone, Waitaki Valley, Otago (Waitakian), Lower Miocene of New Zealand (*transilis*).

DISTRIBUTION: Australia: Bird Rock, Upper beds, L. Miocene of Victoria; Mornington, Balcombe Bay, M. Miocene of Victoria. New Zealand: Clifden, band 6A, Southland (Altonian), M. Miocene.

Shell moderately small, 9 - 17mm, biconic and ovate, width 42 - 53% of length; teleoconch of 5 - 6 almost flat-sided or slightly convex whorls, protoconch of 2 - 2½ smooth, globose and generally tilted nuclear whorls. Sculptured with prominent or somewhat obsolete spiral threads, thin axial riblets or growth striae; spiral threads 6 - 10 on the penultimate whorl 20 - 37 on the body whorl. In some individuals the axial sculpture may become subdued on later whorls and take on the form of obsolete growth striae; occasional specimens are prominently granulose, especially at the point of intersection of axials and spirals. The aperture narrow, longer than the spire, 55 - 68% of total length, smooth within; the labial lip thickened in gerontic specimens and simple. Columella with 4 distant folds, first posterior fold shorter than the second fold. siphonal canal straight.

Mitra othone Tenison-Woods, has been described from a juvenile specimen, still pupiform in shape, with a rather convex and inflated body whorl. The holotype is presumably in the Tasmanian Museum, Hobart; the given dimensions are length 10.0mm, width 4.5mm.

Conomitra othoniana Finlay, is not separable from the Australian population of *Waimatea othone*. Finlay (1924), in his description of the former species, remarked that his "new shell resembles *C.othone* T. Woods so closely as to render its separation a matter of doubt". The holotype and 17 paratypes of *Conomitra othoniana* are in the Auckland Institute & Museum, Auckland, No. TM-199; the dimensions of the holotype are length 13.6mm, width 6.1mm, height of aperture 8.1mm.

The Waitakian *Waimatea transilis* is also conspecific with *W.othone*. In the holotype of *W. transilis*, the axial sculpture is suppressed and visible only in the form of obsolete growth striae; one paratype, however, has axial riblets on 3 - 4 postnuclear whorls. In some Balcombian specimens of *Waimatea othone* examined, axial sculpture was almost completely absent on the last 3 whorls, while in others, the sculpture was distinctly granose. The holotype and 5 paratypes of *W.transilis* are in the Auckland Institute & Museum, Auckland, No. TM-847; the dimensions of the holotype, which has a portion of the aperture missing, are length 11.0mm, width 5.3mm, height of aperture 6.6mm.

The majority of specimens of *Waimatea othone* have 4 columellar folds, and only 2 specimens were encountered, one from Australia and the other from New Zealand, which had a small, fifth anterior fold. One gerontic specimen from Bird Rock, Victoria, had whorls concavely excavated below the suture.

Waimatea lornensis (Marwick, 1926)

1926. *Vexillum lornense* Marwick, Trans. N.Z. Inst., 56: 314, pl. 72, fig. 13.
1966. *Uromitra lornensis* (Marwick), Fleming, N.Z. Geol. Surv. Bull., No. 173: 65, pl. 113, fig. 1377.

TYPE LOCALITY: Waiarekan Tuffs, Lorne, Nth. Otago (Kaiatan), Upper Eocene of New Zealand.

Shell small, fusiform, spire slightly less than aperture. Whorls 5 besides protoconch, slightly convex; body whorl comparatively large, gradually contracted at base. Protoconch paucispiral, globular with tilted apex. Sculpture obsolete, surface obscurely and finely trellised. Aperture narrow, sides subparallel, angled posteriorly, not notched anteriorly. Outer lip thin, convex, antecurrent to suture, retreating to anterior end of columella, but not contracted to a canal. Columella with 3 oblique median folds. (Original description).

Two specimens labelled "*Uromitra lornense*" in the Laws collection from the type locality and Oamaru, were examined. The specimens are imperfect and badly preserved, but both specimens have worn axial ribs and obsolete spirals on the body whorl, and resemble worn examples of *Waimatea amplexa* Finlay. *Waimatea lornensis* is probably a juvenile *Waimatea*, and is in no way related to the vexilline genus *Uromitra* (= *Costellaria*).

The holotype of *Waimatea lornensis* is in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 6.5mm, width 3.0mm.

GENUS **Proximitra** Finlay, 1927

Proximitra Finlay, 1927, Trans. N.Z. Inst., 57: 410. Type species by OD *Vexillum rutidolomum* Suter = *Vexillum* (*Costellaria*)*rutidolomum* Suter, 1917. Lower Miocene of New Zealand (first reviser Preston, 1928, p. 70).

= 1927. *Proximitra* Allan, Trans. N.Z. Inst., 57: 291 [included species *P.parki* (Allan) and *P.plicatellum* (Marshall & Murdoch)]. Upper Eocene of New Zealand.
= 1927. *Proximitra* Finlay, Trans. N.Z. Inst., 57: 410.
= 1931. *Vexillitra* Marwick, N.Z. Geol. Surv. Paleont. Bull., No. 13: 125. Type species by OD *V.balteata* Marwick, 1931. Mid-Miocene of New Zealand.

Shell small to moderate in size, 9 - 33mm, elongate and slender or fusiformly ovate; teleoconch of 4 - 7½ convex, concavo-convex or angulate whorls, protoconch of 1½ - 3 smooth, globose and slightly elevated nuclear whorls. Sculptured with prominent axial ribs and spiral cords; the axial ribs, when present, most prominent on the presutural ramp where they are often nodose, generally fading out towards base of last whorl; in spirally corded species, the interstices axially lirate. The sutures frequently with a smooth girdle. The aperture narrow, equal in height or longer than the spire, smooth within; labial lip thin and simple, angulate or crescent-shaped, constricted anteriorly towards the siphonal canal. Columella with 4 - 5 thin, distant folds, first posterior fold shorter than second, siphonal canal produced.

The genus contains 7 fossil species and one subspecies. *Turricula genotiaeformis* Cossmann, 1896, from the Loire Eocene and *Conomitra apalachee* Gardner, 1937, from the Chipola Miocene, show all essential features of *Proximitra* and have been assigned to this group.

GEOGRAPHICAL DISTRIBUTION: Europe; S.E. United States; Australia; New Zealand.

STRATIGRAPHICAL RANGE: Eocene - Middle Miocene.

Proximitra rutidoloma (Suter, 1917)

(Plate 17, figs. 8 - 9)

1917. *Vexillum*(*Costellaria*)*rutidolomum* Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 5: 29, pl. 4, fig. 10.
1927. *Proximitra rutidolomum* (Suter), Finlay, Trans. N.Z. Inst., 57: 410.
1966. *Proximitra rutidolomum* (Suter), Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: Sand clay above limestone, foot of Mount Horrible (Otaian), Lower Miocene of New Zealand.

DISTRIBUTION: Bluecliffs, Sth. Canterbury (Otaian); Awamoa; Ardgowan shell-pit; Target Gully; Oamaru, Otago (all Awamoan), L. Miocene of N.Z.

Shell medium in size, 20 - 33mm (juveniles down to 8.0mm), elongate ovate, width 38 - 48% of length; teleoconch of 6 - 7 angulate whorls, protoconch of 1½ - 2 smooth and globose nuclear whorls. Sculptured with prominent spiral cords, 7 - 14 on the penultimate whorl, 25 - 55 on the body whorl; whorls convexly shouldered at the presutural ramp, concave below, ornamented with indistinct axial ribs or threads. Axial threads 20 - 30 on the penultimate whorl, 20 - 36 on the body whorl, generally becoming obsolete towards the base. Aperture narrow, longer than the spire, 58-64% of total length, smooth within; labial lip only slightly thickened and simple, angulate and inflexed near commencement. Columella with 4 thin, distant folds, first posterior fold fairly high on the parietal wall; siphonal canal produced and distinct, not notched.

The swelling of the presutural ramp is quite prominent in some specimens and obsolete in others; the spiral and axial sculpture, while discreet in some individuals, is quite prominent and coarse in some specimens, particularly those from Bluecliffs.

The holotype of *Proximitra rutidoloma* is in the Canterbury Museum, Christchurch, No. M-3140. The axial riblets in the type number 23 on both whorls, and the penultimate whorl carries 14 spiral threads, the body whorl 55. The dimensions are length 29.7mm, width 12.8mm, height of aperture 18.9mm.

Proximitra apicalis (Hutton, 1873)

(Plate 17, figs. 10 - 11 and Plate 18, fig. 1)

1873. *Mitra apicalis* Hutton, Cat. Tert. Moll. Echin. N.Z., p. 7.
1915. *Vexillum apicale* (Hutton), Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 3: 20, pl. 1, fig. 5.
1927. *Proximitra apicalis* (Hutton), Finlay, Trans. N.Z. Inst., 57: 410.
1930. *Proximitra apicalis* (Hutton), Finlay, Trans. N.Z. Inst., 61: 61, pl. 5, figs. 68, 72, 73.
1930. *Proximitra partinoda* Finlay, Trans. N.Z. Inst., 61: 62.

TYPE LOCALITY: Awamoa, Oamaru, Otago (Awamoan), Lower Miocene of New Zealand (*apicalis*); Blue Cliffs, Otaio River, Sth. Canterbury (Otaian), Lower Miocene of New Zealand (*partinoda*).

DISTRIBUTION: Rifle Butts and Pukeuri, Oamaru, Otago (Awamoan); Blue Cliffs and Pareora River, Canterbury (Otaian).

Shell moderately small, 9 - 15mm (juvenile specimens down to 5.0mm), fusiformly elongate, width 35 - 45% of length; teleoconch of 4½ - 5½ concave and angulate whorls, protoconch of 1½ - 2 smooth, globose nuclear whorls. Sculptured with irregular, slender axial ribs most prominent above and below the presutural ramp forming nodules on the keel; axial ribs 0 - 18 on the body whorl, 11 - 18 on the penultimate whorl, and may be completely or partially absent from the body whorl. Spiral striae are either elevated and rounded or almost flat, particularly on the centre of the body whorl where replaced by incised spirals; spiral threads *c.* 25 - 40 on the body whorl, 5 - 10 on the penultimate whorl; sutures generally carry a smooth girdle. Aperture narrow and constricted, equal in height or longer than the spire, 53 - 61% of total length, smooth within; labial lip crescent-shaped, constricted towards the base, anterior canal produced. Columella with 4 distant folds, first posterior fold generally thinner and shorter than the second.

The species is variable in sculpture, particularly in the size and spacing of the nodules on the peripheral keel, where spiral threads become occasionally very prominent. The Otaian *Proximitra partinoda* has been based on specimens of *P.apicalis* with obsolete axial sculpture on the body whorl. The holotype of *P.partinoda* and 2 paratypes are in the Auckland Institute & Museum, Auckland, No. TM-640; the dimensions of the holotype are length 10.1mm, width 6.8mm, height of aperture 6.1mm.

The holotype of *Proximitra apicalis* is in the N.Z. Geological Survey collection, Lower Hutt. The type has 11 obsolete axials and *c.* 32 spirals on the body whorl, and 16 subobsolete axials and 8 spirals on the penultimate whorl; the dimensions of the holotype are length 11.4mm, width 4.3mm, height of aperture 6.0mm.

Proximitra balteata (Marwick, 1931)

(Plate 18, fig. 2)

1931. *Vexillitra balteata* Marwick, N.Z. Geol. Surv. Palaeont. Bull., No. 13: 125, pl. 13, fig. 246.

TYPE LOCALITY: Akiripuraho Stream, 60 chains from mouth, Whaingaromia, Gisborne District (Altonian-Clifdenian), Mid-Miocene of New Zealand.

Shell small, broadly fusiform, shining, protoconch of about 2 smooth whorls, with a large nucleus. Sculpture of about 24 weak, flat axial ribs extending from suture to suture but dying out on the base. The angulation of the shoulder, below which the whorl is strongly constricted, furnished with a projecting girdle, on which the axials raised into sharply angled, spirally elongated tubercles. Suture bordered below by a somewhat weak thread, the neck bears about 5 or 6 more. Aperture elongate, narrow, not notched anteriorly, columella with 4 thin, high, distant plaits, the second top strongest. (Original compounded description).

Vexillitra bolteata Marwick, the type species of *Vexillitra* Marwick, 1931, is a juvenile specimen of *Proximitra*, and is most probably the young of *P.apicalis* (Hutton). No difficulty was experienced in selecting juvenile specimens of *P.apicalis* which agreed with *P.bolteata* in all essential characters of form, sculpture, projecting nodes on the carina and columellar folds.

The holotype of *Proximitra bolteata* is in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 7.3mm, width 3.8mm. The type, which has not been personally examined, should be compared with juvenile specimens of *Proximitra apicalis* (Hutton).

Proximitra genotiaeformis (Cossmann, 1896)

1824. ? *Mitra corrugata* Defrance in Blainville, Dict. Sci. Nat., 31: 493 (non Lamarck, 1811).
1896. *Turricula* ? *genotiaeformis* Cossmann, Bull. Soc. Sci. Nat. L'Ouest France, 6: 109, pl. 9, figs. 27, 28.

TYPE LOCALITY: La Close, Eocene of France.

Shell moderate in size, 19 - 27mm, with 7 subangulate, concavo-convex whorls; sutures linear and with a bifid sutural girdle. Sculptured with oblique axial ribs becoming obsolete on the body whorl, and numerous fine spiral threads; spiral striae become granose at the point of intersection with the axial ribs. Aperture longer than the spire, narrow, smooth within; labial lip thin and simple, angulate, constricted basally. Columella with 4 thin and distant folds, siphonal canal produced.

Cossmann (1896) remarked on the resemblance of his new species to the turrid genus *Genotia*, and was unable to match it with any comparable species from the Paris Basin Eocene. This European species is the only genuine *Proximitra* from Europe which the writer was able to trace. The holotype is in the Dumas collection; the given dimensions are length 19.0mm, width 7.5mm, height of aperture 11.0mm.

Proximitra tumens Finlay, 1930

(Plate 18, fig. 3)

1930. *Proximitra tumens* Finlay, Trans. N.Z. Inst., 61:62, pl. 5, figs. 67, 69 - 71.
1966. *Proximitra tumens* Finlay, Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: Pukeuri, sandy beds in the road cutting, Oamaru, Otago (Awamoan), Lower Miocene of New Zealand.

DISTRIBUTION: Rifle Butts, All Day Bay and Awamoa, all Oamaru, Otago (Awamoan); Pareora, Canterbury (Awamoan).

Shell moderately small, 11 - 17mm, fusiformly ovate, width 41 - 46% of length. Protoconch and sculpture as in *Proximitra apicalis*; axial riblets only slightly more numerous, 6 - 23 on the body whorl, 17 - 23 on the penultimate whorl. The spire less fusiform and the body whorl more convex and inflated than in *P.apicalis*. The aperture generally longer, height 57 - 68% of length, more open and less constricted anteriorly; the labial lip distinctly angulate, descending almost vertically after commencement, less contracted towards the anterior canal which is also shorter.

The 22 specimens examined were differentiated from *Proximitra apicalis* on features of less fusiform spire, inflated body whorl, less concave outline of body whorl anteriorly, open aperture, angulate labial lip and shorter siphonal canal. *Proximitra tumens* could possibly be an extreme form of *P.apicalis* as pointed out by Finlay (1930), but a larger series containing specimens with intergrading characters would be required in order to confirm this assumption.

The holotype of *Proximitra tumens* is in the Auckland Institute & Museum, Auckland, No. TM-642; the dimensions are length 16.7mm, width 6.8mm, height of aperture 9.8mm.

Proximitra apalachee (Gardner, 1937)

(Plate 18, fig. 4)

1915. *Conomitra staminea* (Conrad), Dall, Bull. U.S. Nat. Mus., 90: 62, pl. 10, fig. 2.
1937. *Conomitra apalachee* Gardner, U.S. Geol. Surv. Prof. Pap., No. 142F: 420, pl. 48, fig. 36.

TYPE LOCALITY: No. 3419, 1 mile below Baileys Ferry, Chipola River, Calhoun County, Florida, Lower Miocene of S.E. United States.

DISTRIBUTION: Gardner (1937) records the species from Lower Beds, Alum Bluff, Liberty County, Mid-Miocene of Florida. Dall (1915) reported the species (as *Conomitra staminea*) from Ballast Point and Orient Station near Tampa, Lower Miocene of Florida.

Shell of moderate dimensions, rather thin, spire elevated and evenly terraced, whorls 9½ in the type, 7½ of these included in the conch. Protoconch small, smooth, polished, obtuse, moderately elevated, the initial turn broadly rounded and partly submerged. Axials narrow, obtuse, cord-like vertical, weakening a little upon the rounded shoulder but persisting with uniform prominence from the shoulder to the anterior suture and well down to the base of the body whorl, 21 upon the initial postnuclear whorl of the type increasing to 28 upon the body. Spiral sculpture introduced near the close of the first whorl of the conch in the form of 2 or 3 faintly impressed sulci all of them in front of the median horizontal; sulci developing on the later volutions, 3 upon the penult of the type and 16 in number upon the body. Base of the body and pillar sculptured with 4 or 5 broader grooves, separated by more elevated fillets. Aperture narrow, oblique, the margins approximately parallel; outer lip thin, sharp, flexed at the shoulder and produced backward for a short distance upon the penult. Columellar plications very slightly oblique, thin, parallel to one another, separated in the type by interspaces of double the width; a fifth very obscure fold developed in front of the 4 major plications. Canal short, ill-defined, broad, open very slightly flexed, obliquely truncated at its extremity.

The obtuse protoconch, thin and distant columellar folds with the first posterior fold shorter than the second one and absence of a siphonal notch, place the species in the Volutomitridae. The "labial plications" of Gardner (1937) are a *lapsus* for "columellar plications"; an examination of the type revealed a smooth labrum. The Chipola species bears a close resemblance to the *Proximitra* group of Volutomitridae, and the species has been assigned to this group on the basis of common morphological features. Examination of Oligocene and Miocene "*Conomitra*" species from U.S. deposits may bring to light further records of Volutomitridae of the *Proximitra* group. The distributional pattern of *Proximitra* is similar to the distribution of the Eocene cymatid *Personella,* which has been also recorded from deposits in Europe, America and New Zealand.

The holotype of *Proximitra apalachee* is in the U.S. National Museum, USNM 371450; the given dimensions are length 24.8mm, width 10.5mm, height of aperture 16.5mm.

Proximitra atractoides atractoides (Tate, 1889)

(Plate 18, fig. 5)

1880. ? *Mitra anticoronata* Johnston, Proc. Roy. Soc. Tasmania, p. 34.
1889. *Mitra atractoides* Tate, Proc. Roy. Soc. Sth. Australia, 11: 139, pl. 4, fig. 11.
1897. *Mitra(Cancilla)atractoides* Tate, Harris, Cat. Tert. Moll. Brit. Mus., p. 123, pl. 5, fig. 2a, b (protoconch).

TYPE LOCALITY: Lower beds at Muddy Creek, Victoria, Mid-Miocene of Australia (*atractoides*); Table Cape, Lower Miocene of Tasmania (*anticoronata*).

DISTRIBUTION: Upper beds, Bird Rock, Lower Miocene of Victoria; Grice's Creek, Mid-Miocene of Victoria.

Shell moderately small, 13 - 22mm, fusiformly elongate or fusiformly ovate, width 33 - 43% of length; teleoconch of 4 - 5 convex whorls, protoconch of 2½ - 3 subcylindrical, obtuse and smooth nuclear whorls. Sculptured with close-set spiral cords, 6 - 9 on the penultimate whorl, 25 - 35 on the body whorl; arcuate axial growth striae bisect spiral threads, but growth striae may be obsolete in some specimens. Aperture narrow, equal in height or longer than the spire, 53 - 64% of total length, smooth within; labial lip thin and simple, constricted anteriorly. Columella with 4, rarely 5, thin and distant folds, first posterior fold shorter than the second fold in adult specimens; siphonal canal somewhat produced and distinct, siphonal notch absent.

Johnston (1880) described but did not illustrate *Mitra anticoronata,* and the species was neither re-described nor figured subsequent to its description. Ludbrook (1967) reported on Johnston's and Tenison-Woods' Table Cape fossil molluscs, but omitted to mention *M.anticoronata*; it is assumed that the type is missing from the Tasmanian Museum in Hobart. A specimen in the Finlay Tertiary mollusc collection is labelled "*Mitra anticoronata* Johnston", from Table Cape, and this particular specimen is conspecific with *Proximitra atractoides* (Tate). Johnston's description of *Mitra anticoronata* agrees fairly well with *Proximitra atractoides,* but some doubt could exist if his species was not really *Waimatea othone* (Tenison-Woods). Until the type or other authentic material can be located, *Mitra anticoronata* Johnston is considered a *nomen dubium.* The dimensions given by Johnston for his species are length 13.0mm, width 5.0mm, height of aperture 7.0mm.

Harris (1897) described the protoconch of *Proximitra atractoides* as consisting of 4 whorls, but specimens examined showed the 4th turn to be already sculptured and a part of the teleoconch. The holotype of *P.atractoides* is presumably in the Tate Museum collection at the University of Adelaide, Sth. Australia; the given dimensions are length 21.0mm, width 7.0mm, height of aperture 12.0mm.

Proximitra atractoides armorica (Suter, 1917)

(Plate 18, fig. 6)

1917. *Mitra(Cancilla)armorica* Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 5: 27, pl. 12, fig. 4.
1924. *Mitra(Cancilla)armorica* Suter, Finlay, Trans. N.Z. Inst., 55: 468, pl. 50, figs. 4a, b.
1930. *Proximitra armorica* (Suter), Finlay, Trans. N.Z. Inst., 61: 258.
1969. *Proximitra armorica* (Suter), Maxwell, Trans. Roy. Soc. N.Z., 6 (13): 162.

TYPE LOCALITY: Sandy clay lying immediately on top of the limestone, Blue Cliffs, near St. Andrews, Sth. Canterbury (Otaian), Lower Miocene of New Zealand.

DISTRIBUTION: Otiake, Waitaki Valley; Otekaike limestone, Otekaike Valley; Brothers Stream, Hakataramea (all Waitakian), L. Miocene; Wharekuri greensand, Waitaki Valley, U. Oligocene of New Zealand.

Similar to *W.atractoides* (Tate), and can be separated only by the differently formed protoconch. Adult specimens range in size from 17 - 31mm, but juveniles are as small as 9.0mm; the width ratio is 34 - 38% of length. Spiral cords number from 4 - 15 on the penultimate whorl and from 30 - 50 on the body whorl. Fully mature whorls number from 5 - 6, and the protoconch has $1\frac{1}{2}$ - 2 smooth and globose nuclear whorls; the height of the aperture is 57 - 62% of total shell length.

The mature whorls are slightly more numerous and embryonic whorls less numerous in the subspecies *armorica* than in the nominate species; the protoconch is not as subcylindrical and depressed as in *P.atractoides* s.str. In some specimens of *P.atractoides armorica,* the spiral cords are most prominent at the sutures and obsolete towards the centre of the body whorl; axial growth striae or thin riblets are more distinct on the early postnuclear whorls.

Both Suter (1917) and Finlay (1924) remarked on the close resemblance of the New Zealand *P.armorica* to the Australian *P.atractoides,* but neither author had the opportunity to compare specimens of both species. The New Zealand form is retained here as a subspecies based on the features of the protoconch, but a larger series of specimens of the Australian *P.atractoides* is required to confirm constant differences in protoconch features.

The holotype of *Proximitra atractoides armorica* is in the Canterbury Museum, Christchurch; the given dimensions are length 20.0mm, width 8.0mm.

SUBGENUS Parvimitra Finlay, 1930 (of *Proximitra*)

Parvimitra Finlay, 1930, Trans. N.Z. Inst., 61: 63. Type species by OD *P.pukeuriensis* Finlay, 1930. Lower Miocene of New Zealand.

Shell small to very small, 5 - 12mm, fusiformly ovate, teleoconch of $3\frac{1}{2}$ - $4\frac{1}{2}$ convex or concavo-convex whorls, protoconch of $1\frac{1}{2}$ - 2 depressed and globose nuclear whorls. Sculpture as in *Proximitra,* but the spiral threads are less prominent. Aperture longer than the spire, smooth within, labial lip angulate or crescent-shaped; columella with 4 distant or closer set folds, siphonal canal short, siphonal notch absent.

Species of *Parvimitra* are smaller and less fusiform than species of *Proximitra,* and have fewer whorls, a flatter and more depressed protoconch, less prominent spiral sculpture and a shorter siphonal canal *Parvimitra* is closely related to both *Proximitra* and *Peculator,* and the subgenus became extinct during Lower Pliocene times. The subgenus contains only 4 fossil species which are confined to Australian and New Zealand Tertiary deposits.

GEOGRAPHICAL DISTRIBUTION: Australia and New Zealand.

STRATIGRAPHICAL RANGE: Lower Miocene - Lower Pliocene.

Proximitra (Parvimitra) paucinoda (Finlay, 1930)

(Plate 18, fig. 17)

1930. *Proximitra paucinoda* Finlay, Trans. N.Z. Inst., 61: 62.

TYPE LOCALITY: Blue Cliffs, Otaio River, Sth. Canterbury (Otaian), Lower Miocene of New Zealand.

Shell small, 7 - 12mm, elongate ovate, biconic and moderately solid, width 45-48% of length; teleoconch of 3½ - 4 concavo-convex whorls, protoconch of 2 smooth, depressed and globose nuclear whorls. Sculptured with close-set spiral threads, about 5 - 9 on the penultimate whorl, 30 - 50 on the body whorl; spiral striae generally weak near the sutures, becoming more prominent on the presutural ramp and weaker below. Whorls concave posteriorly but swelling out convexly towards the anterior of the suture. Axial ribs most prominent on the presutural ramp, bluntly nodose there in adult specimens and more spinose in juveniles; axial ribs 10 - 12 on both whorls tending to become obscure and thin towards the base of the body whorl, except in juveniles. The aperture narrow, longer than the spire, 66 - 69% of total length, smooth within; labial lip angulate, slightly thickened and simple, contracted towards the base. Columella with 4 thin and distant folds, siphonal canal straight or slightly recurved.

The holotype of *Proximitra(Parvimitra)paucinoda* is in the Auckland Institute & Museum, Auckland, No. TM-641; the dimensions are length 11.4mm, width 5.3mm, height of aperture 7.5mm. The species appears to be confined to the Blue Cliffs deposits, and closely resembles some individuals of *P.(P.)pukeuriensis* (Finlay).

Proximitra (Parvimitra) pukeuriensis (Finlay, 1920)

(Plate 18, figs. 8 - 10)

1930. *Parvimitra pukeuriensis* Finlay, Trans. N.Z. Inst., 61: 63, pl. 3, figs. 37 - 41.
1930. *Parvimitra scopi* Finlay, Trans. N.Z. Inst., 61: 64.
1930. *Parvimitra ponsatanae* Finlay, Trans. N.Z. Inst., 61: 64, pl. 3, fig. 29.

TYPE LOCALITY: Pukeuri, sandy clays in road cutting, Oamaru, Otago (Awamoan), Lower Miocene of New Zealand (*pukeuriensis*); Target Gully shell-bed, Oamaru, Otago (Awamoan) (*scopi*); Ardgowan shell-pit, Oamaru, Otago (Awamoan) (*ponsatanae*).

DISTRIBUTION: Awamoa, Oamaru, Otago; Rifle Butts, Oamaru, Otago (Awamoan), Lower Miocene of New Zealand.

Shell small, 6 - 9mm, juvenile specimens smaller, elongate ovate, biconic, width 43 - 52% of length; teleoconch of 3½ - 4 concavo-convex whorls, protoconch of 1½ - 2 smooth, depressed and globose nuclear whorls. Sculptured with axial ribs which become nodulose on the presutural ramp but tend to be obsolete above and below the periphery and sometimes towards the labial lip of the body whorl; axial ribs 8 - 22 on the body whorl, 9 - 22 on the penultimate whorl. Spiral striae generally obsolete, but well defined in better preserved specimens from Rifle Butts and occasionally Pukeuri; spiral threads 3 - 10 on the penultimate whorl, the body whorl carrying up to 33 spirals. Some specimens with a fine sutural girdle, usually more distinct on early whorls. The aperture narrow, longer than the spire, 60 - 69% of total length, smooth within, the labial lip moderately thin and simple, crescent-shaped, scarcely contracted anteriorly. Columella with 4 moderately strong and less distant folds, first posterior fold often shorter than the second; siphonal canal short, straight or slightly recurved.

Finlay's treatment of this group of small *Parvimitra* species is most unsatisfactory. In his description of *P.scopi,* Finlay remarked that *scopi* differs from *pukeuriensis* only in "having stronger and fewer nodules, tending to become wider apart", but remarked that six shells from the Target Gully locality could not be separated from *pukeuriensis.* The author suggested the possibility of *P.(P.)scopi* and *P.(P.)ponsatanae* being facies-forms of *pukeuriensis,* but despite his own observations

proceeded to describe these facies-forms as new species. It is never difficult to select end members, i.e. atypical specimens, as representatives of a new species, but such atypical specimens are generally recognized without difficulty as individual variants of natural populations of a species provided a larger series of specimens is available for examination. Eighty-seven specimens of *P.(P.)pukeuriensis*, nineteen specimens of *P.(P.)scopi* and the holotype of *P.(P.)ponsatanae* were available for examination. It was found that the differentiating character of "stronger and fewer nodules" was an integrading feature present in both *P.(P.)pukeuriensis* and *P.(P.)scopi*. An atypical specimen with numerous and axially elongated axial riblets was selected as the holotype of *P.(P.)ponsatanae*.

The holotypes of the three *Parvimitra* species are in the Auckland Institute & Museum, Auckland. The dimensions are as follows: holotype of *P.(P.)pukeuriensis* No. TM-591, length 6.8mm, width 3.3mm, height of aperture 4.3mm. The holotype of *P.(P.)scopi* No. TM-592, length 6.4mm, width 3.2mm, height of aperture 4.2mm. The holotype of *P.(P.)ponsatanae* No. TM-590, length 7.5mm, width 3.5mm, height of aperture 4.6mm.

Proximitra(Parvimitra)pukeuriensis closely resembles *P.(P.)paucinoda* (Finlay) from the lower strata of the Otaian stage. The Blue Cliff specimens are well preserved due to the blue clay deposits of the locality, and the sculpture has remained unimpaired, and is crisper and more prominent than in specimens from arenaceous sandy-clay deposits of Pukeuri and Target Gully. In proportions of width and height of aperture, the two species are very similar, but *P.(P.)paucinoda* is slightly larger, the spiral threads are more numerous, and the peripheral nodules are not fewer, as pointed out by Finlay (1930), but rather wide spaced and slightly spinose. In *P.(P.)paucinoda*, 3 - 5 spiral threads are always very prominent on the presutural ramp, but this feature has also been observed in 10 specimens of *P.(P.)pukeuriensis*. The thin sutural girdle present on the early whorls of *P.(P.) pukeuriensis* has also been seen in individuals of *P.(P.)paucinoda*. The value of the subgenus *Parvimitra* appears to be negated when the author himself placed such closely related species as *P.(P.) paucinoda* and *P.(P.)pukeuriensis* in different genera.

Proximitra (Parvimitra) clathurella (Tate, 1889)
(Fig. 219)

1889. *Mitra clathurella* Tate, Proc. Roy. Soc. Sth. Australia, 11: 142, pl. 8, fig. 8.
1897. *Uromitra clathurella* (Tate), Harris, Cat. Tert. Moll. Brit. Mus., p. 128.

TYPE LOCALITY: Lower beds at Muddy Creek, Victoria, Mid-Miocene of Australia.

Shell small, 5 - 6mm, fusiformly ovate, width *c.* 46 - 51% of length; teleoconch of 3½ - 4 convex, subangulate whorls, protoconch of 2 smooth, obtuse nuclear whorls. The area between the presutural ramp and the sutures concave, the sutures carry a narrow girdle. Sculptured with coarse axial ribs, 16 - 20 on the penultimate whorl, *c.* 18 on the body whorl; prominent spiral striae bisect axial ribs, *c.* 6 on the penultimate whorl, 16 on the body whorl, and usually become granulose at the point of intersection with axial ribs. The aperture narrow, longer than the spire, 55 - 67% of length, smooth within; the labial lip thickened and simple, contracted anteriorly. Columella with 4 folds, first posterior fold thinner and shorter than the second.

Harris (1897) remarked that Tate's drawing appears more granose than are actual specimens, and this indeed seems to be the case; the axial ribs are more prominent and somewhat stouter than the spiral threads.

The holotype of *Proximitra(Parvimitra)clathurella* is presumably in the Tate Museum collection at the University of Adelaide, Sth. Australia; the given dimensions are length 6.0mm, width 2.75mm, height of aperture 4.0mm.

Fig. 219. *Proximitra(Parvimitra)clathurella* (Tate, 1889). Muddy Creek, Victoria, M. Miocene of Australia; length 6.0mm (from Tate, 1889, pl. 8, fig. 8).

Proximitra (Parvimitra) plicifera (Marwick, 1928)

(Fig. 220)

1928. *Austromitra plicifera* Marwick, Trans. N.Z. Inst., 58: 485, fig. 129.
1966. *Parvimitra plicifera* (Marwick), Fleming, N.Z. Geol. Surv. Bull., No. 173: 64, pl. 113, fig. 1380.

TYPE LOCALITY: Whenuataru Peninsula, Pitt Island, Chatham Islands (Opoitian), Lower Pliocene of New Zealand.

Shell small, fusiform; spire gradate. Protoconch slightly bulbous of two smooth relatively large whorls. Post-embryonic whorls four, with well-defined almost horizontal shoulder, body whorl contracting rather slowly to the short neck which has no fasciole. Sculpture of 25 to 30 low, rounded axial ribs per whorl, the ribs not reaching across shoulder and on later whorls scarcely as far as anterior suture; traces of obsolete spiral cords visible. Aperture long and rather narrow, contracting gradually above, not notched below. Outer lip thin, simple, lightly ascending. Columella straight, with three strong folds. (Original description).

Proximitra (Parvimitra) plicifera, correctly assigned to the *Parvimitra* group by Finlay (1930), is the only *Parvimitra* species which survived the Miocene, provided that the calcareous tuffs at Whenuataru are of Lower Pliocene age.

The holotype is in the N.Z. Geological Survey, Lower Hutt; the given dimensions are length 10.0mm, width 5.5mm.

Fig. 220. *Proximitra (Parvimitra) plicifera* (Marwick, 1928). Whenuataru Peninsula, Chatham Islands, L. Pliocene of New Zealand; length 10.0mm (from Marwick, 1928, fig. 129).

DUBIOUS SPECIES OF VOLUTOMITRIDAE

Mitra (Volutomitra) porcellana Melvill & Standen, 1912

1912. *Mitra (Volutomitra) porcellana* Melvill & Standen, Trans. Roy. Soc. Edinburgh, 48: 355, fig. 21.

TYPE LOCALITY: Scotia Bay, Sth. Orkneys, 9 - 10 fathoms (16 - 18 metres); also Burdwood Bank, in 56 fathoms (102 metres).

Melvill & Standen's type lot consisted of 2 dead and broken shells, *c.* 14mm in length. The figured type shows some resemblance to *Volutomitra (Paradmete) crymochara* (Rochebrune & Mabille, 1885), but also exhibits distinct affinities with some Subantarctic Marginellidae. The species remains undefined.

Euthria (Dennantia ?) mystica Suter, 1917

1917. *Euthria (Dennantia ?) mystica* Suter, N.Z. Geol. Surv. Palaeont. Bull., No. 5: 32, pl. 12, fig. 7.
1966. *"Mitra" mystica* (Suter), Fleming, N.Z. Geol. Surv. Bull., No. 173: 64.

TYPE LOCALITY: No. 164, coal beds, Kakahu River, Sth. Canterbury (Bortonian), Mid-Eocene of New Zealand.

Shell elongate, slightly turreted, surface reticulated, the whorls separated by a deep suture. Sculpture consisting of spiral cords, about 8 on the penultimate whorl, with linear interstices, crossed by less distinct axial riblets of same strength as the spirals, producing low tubercles at the point of intersection, and reticulating the whole surface. Spire narrowly conic, about the same height as the aperture, angle about 33°. Protoconch lost. Whorls 4½, but very likely about 7 in a perfect shell, very lightly and narrowly shouldered, flat below, the body whorl a little

convex, contracted anteriorly. Suture deep, producing a somewhat scalar aspect of the shell. Aperture ovate, apparently with a canal directed to the left, the specimen being too imperfect to make out further and important details. (Original description).

The type, with a missing spire and matrix-filled aperture, is incomplete and badly preserved, and the species cannot be associated with any mitrid or volutomitrid genus. The holotype is in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 20.0mm, width 9.0mm.

Vexillum fractum Marwick, 1926

(Fig. 221)

1926. *Vexillum fractum* Marwick, Trans. N.Z. Inst., 56: 321, pl. 73, fig. 12.
1931. *Vexillitra fracta* Marwick, N.Z. Geol. Surv. Palaeont. Bull., No. 13: 124.
1966. *Vexillitra fracta* (Marwick), Fleming, N.Z. Geol. Surv. Bull., No. 173: 65, pl. 113, fig. 1379.

TYPE LOCALITY: 1133, Mimi Stream, Nth. Taranaki (Tongaporutuan), Upper Miocene of New Zealand.

Shell small, broadly fusiform, spire turreted, about equal in height to aperture. Whorls strongly angled, with high narrow shoulder and vertical sides; body whorl similar above, rounded off on base and contracting quickly to short neck. Sculpture: about 16 weak axial ribs gathered into strong beads on shoulder-angle and becoming obsolete on base; strong moniliform spiral follows shoulder-angle, otherwise spirals obsolete. Aperture long and narrow, not notched below. Columella with 4 oblique folds. (Original description).

The figured specimen is evidently a very young post-veliger of a *Parvimitra* or *Proximitra*. The teleoconch, counted from the dorsal view of the figured type, consists of only $2\frac{1}{4}$ - $2\frac{1}{2}$ mature whorls and the protoconch of about $1\frac{1}{2}$ nuclear whorls. The nodulose sculpture and prominent spirals on the presutural ramp are in agreement with species of *Parvimitra* or *Proximitra*, but at this stage of development, a more exact subgeneric placement is impossible.

The holotype of *Vexillum fractum* is presumably in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 6.0mm, width 3.0mm.

Fig. 221. *Proximitra* (*Parvimitra*?)*fracta* (Marwick, 1926). Mimi Stream, Nth. Taranaki, U. Miocene of New Zealand, length 6.0mm (from Marwick, 1926, pl. 73, fig. 12 — as *Vexillum fractum*).

SPECIES TENTATIVELY ASSIGNED TO THE VOLUTOMITRIDAE

Volutomitra (*Latiromitra* ?) *bairdii* (Dall, 1889)

(Plate 18, fig. 11)

1889. *Mitra*(*Turris*?)*bairdii* Dall, Bull. Mus. Comp. Zool. Harvard, 18: 161.
1889. *Mitra bairdii* Dall, Bull. U.S. Nat. Mus., No. 37: 110, 189, pl. 42, fig. 7.
1890. *Mitra bairdii* Dall, Proc. U.S. Nat Mus., 12: 315, pl. 11, fig. 7.

TYPE LOCALITY: Sta. 2628, 100 miles S.E. by S. from Cape Fear, Nth. Carolina, yellow mud, 528 fathoms (966 metres), at 38.7°F (4°C), ex-*Albatross*.

Shell moderate in size, *c.* 35.0mm, uniformly brown in colour, fusiformly elongate, almost terebriform, width *c.* 25% of length; teleoconch of 10 flat-sided whorls, protoconch missing. Sculptured with irregular, slightly arcuate axial ribs, *c.* 20 on the body whorl, 17 on the penultimate whorl, axial ribs becoming subobsolete on the last whorl; spiral striae very fine and visible

under magnification. Aperture porcellaneous-white, shorter than the spire, *c.* 34% of length, smooth within; the labial lip moderately thin and simple, parallel to columella, slightly angulate near commencement. Columella with 4 folds, first two posterior folds distant, siphonal canal straight, siphonal notch lacking.

The species has the aspects of a *Volutomitra* despite the rather unusual slender and terebriform shape. The holotype of *Volutomitra bairdii* is in the U.S. National Museum, Washington, USNM 86962; the dimensions are length 34.2mm, width 8.6mm, height of aperture 11.6mm.

SPECIES EXCLUDED FROM THE VOLUTOMITRIDAE

Vexillitra marwicki Vella, 1954

(Fig. 222)

1954. *Vexillitra marwicki* Vella, Trans. Roy. Soc. N.Z., 81: 544, pl. 26, fig. 16.
1966. *Vexillitra marwicki* Vella, Fleming, N.Z. Geol. Surv. Bull., No. 173: 65.

TYPE LOCALITY: N 165/507, Bells Creek, Middle Tongaporutuan, Upper Miocene of New Zealand.

Small, ovate-fusiform, glossy. Protoconch of 1½ smooth whorls, followed by 4½ post-nuclear whorls. Shoulder narrower than in *V.fracta* Marwick, with weaker moniliform girdle on the shoulder angle. Thirteen strong rounded axial ribs a whorl, from suture to suture, obsolete on the latter part of the body whorl of most specimens. Sides of whorls not vertical as in *fracta,* but expanding below the shoulder. Body whorl convex, expanding from the shoulder to the suture level then contracting rapidly. (Original description).

The sloping, close-set columellar folds and type of protoconch disassociate *V.marwicki* from the Volutomitridae. The species is an immature *Austromitra,* in the family Mitridae.

The holotype of *Vexillitra marwicki* is in the N.Z. Geological Survey collection, Lower Hutt; the given dimensions are length 6.4mm, width 3.2mm.

Fig. 222. *Austromitra marwicki* (Vella, 1954). Bell's Creek, U. Miocene of New Zealand; length 6.4mm (from Vella, 1954, pl. 26, fig. 16—as *Vexillitra marwicki*).

PLATES 13 - 18

FAMILY VOLUTOMITRIDAE

PLATE 13

Fig. 1. *Volutomitra*(*Volutomitra*)*groenlandica* (Beck in Möller, 1842). Wellington Channel, Arctic Seas, ex-*Belcher*; USNM 86974, length 17.0mm, width 7.3mm. Type species of *Volutomitra* H. & A. Adams, 1853.

Fig. 2. *V.*(*V.*)*alaskana* Dall, 1902. S.E. of Pribiloff Islands, Bering Sea, 74 fathoms (13 metres), at 37.9°F (3°C); USNM 225572, length 47.0mm, width 18.6mm.

Fig. 3. *V.*(*V.*)*alaskana* Dall, 1902. Dorsal side of operculum.

Fig. 4. *V.*(*V.*)*alaskana* Dall, 1902. Ventral side of operculum.

Fig. 5. *V.*(*V.*)*alaskana* Dall, 1902. Off Sado Island, Japan, 200 fathoms (366 metres), at 33.9°F (1°C); USNM 205305, length 22.6mm, width 9.4mm.

Fig. 6. *V.*(*V.*)*banksi* (Dell, 1951). Chatham Rise, New Zealand, 290 fathoms (531 metres); length 42.5mm, width 16.6mm (from Dell, 1956, pl. 17, fig. 170).

Fig. 7. *V.*(*V.*)*pailoloana* (J. Cate, 1963). Pailolo Channel, Hawaiian Islands, 256 - 283 fathoms (468 - 518 metres), U.S. Fish Commission; holotype USNM 173008, length 18.0mm, width 7.0mm.

Fig. 8. *Volutomitra*(*Latiromitra*)*problematica* (Ponder, 1968). Portobello St. Mu-66/59, E. of Taiaroa Heads, New Zealand, 65 fathoms (119 metres); holotype DM M-21553, length 33.1mm, width 12.9mm, height of aperture 18.2mm.

Fig. 9. *V.*(*L.*)*cryptodon* Fischer, 1882. W. of Morocco, Atlantic Ocean, 1900 metres (1038 fathoms); holotype of *Latiromitra specialis* Locard, 1897, length 31.0mm, width 10.0mm (from Locard, 1897, pl. 14, figs. 30, 31). Type species of *Latiromitra* Locard, 1897.

Fig. 10. *Volutomitra*(*Paradmete*)*fragillima* Watson, 1882. Discovery St. 159, Nth. of Sth. Georgia, 160 metres (87 fathoms); Powell coll., AIM, length 23.3mm, width 10.4mm. Type species of *Paradmete* Strebel, 1908.

Fig. 11. *V.*(*P.*)*curta* (Strebel, 1908). Banzare St. 39, off Enderby Land, Antarctic, 300 metres (164 fathoms); Powell coll., AIM, length 10.7mm, width 6.1mm (specimen with 2 columellar folds).

Fig. 12. *V.*(*P.*)*curta* (Strebel, 1908). Banzare St. 39, off Enderby Land, Antarctic, 300 metres (164 fathoms); Powell coll., AIM, length 9.3mm, width 4.8mm (specimen with 4 columellar folds).

Fig. 13. *V.*(*P.*)*curta* (Strebel, 1908). Discovery St. 27, West Cumberland Bay, Sth. Georgia, 110 metres (60 fathoms); Powell coll., AIM, length 20.7mm, width 10.8mm (forma *longicauda* Strebel, 1908).

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PLATE 14

Fig. 1. *Volutomitra(Paradmete)crymochara* (Rochebrune & Mabille, 1885). Discovery St. 388, between Cape Horn and Staten Island, 121 metres (66 fathoms); Powell coll., AIM, length 20.5mm, width 7.5mm.

Fig. 2. *Conomitra fusoides* (Lea, 1833). Claiborne, Alabama, M. Miocene of S.E. United States; lectotype ANSP 5868, length 10.0mm, width 5.5mm (from Palmer, 1937, pl. 66, fig. 26). Type species of *Conomitra* Conrad, 1865.

Fig. 3. *C.glabra* (Ravn, 1933). Nez, Faxe, Paleocene of Denmark; length 10.5mm, width 3.8mm (from Ravn, 1933, pl. 7, fig. 5a—as *Turricula(Fusimitra)glabra*).

Fig. 4. *C.marginata* (Lamarck, 1803). Barton beds, U. Eocene of England; Dept. Geology, BMNH, length 9.0mm.

Fig. 5. *C.parva* (J. de C. Sowerby, 1823)—sculptured form. Barton beds, U. Eocene of England; Dept. Geology, BMNH, length 6.0mm.

Fig. 6. *C.parva* (J. de C. Sowerby, 1823)—smooth form. Upper Bracklesham beds, U. Eocene of England; Dept. Geology, BMNH, length 6.4mm.

Fig. 7. *C.plicatella* (Marshall & Murdoch, 1923)—broad form. McCullough's bridge, Waihao River, U. Eocene of New Zealand; topotype AIM 9666, length 6.9mm, width 3.3mm.

Fig. 8. *C.plicatella* (Marshall & Murdoch, 1923). McCullough's bridge, Waihao River, U. Eocene of New Zealand; paratype of *Parvimitra subplicatella* Finlay, 1930, AIM TM-593, length 5.5mm, width 3.0mm (juvenile specimen).

Fig. 9. *C.plicatella* (Marshall & Murdoch, 1923)—slender form. McCullough's bridge, Waihao River, U. Eocene of New Zealand; holotype of *Parvimitra allani* Finlay, 1930, AIM, TM-588, length 8.2mm, width 3.1mm.

Fig. 10. *C.plicatella* (Marshall & Murdoch, 1923). McCullough's bridge, Waihao River, U. Eocene of New Zealand; paratype of *Parvimitra allani* Finlay, 1930, AIM TM-588, length 7.3mm, width 3.0mm.

Fig. 11. *C.wainuioruensis* (Vella, 1954). Wainuioru River, U. Miocene of New Zealand; length 6.1mm, width 3.4 mm (from Vella, 1954, pl. 26, fig. 15) (immature specimen).

Fig. 12. *C.pentaploca* (Finlay, 1927). Mornington, Balcombe Bay, Victoria, M. Miocene of Australia; AIM, length 6.8mm, width 2.9mm.

Fig. 13. *Peculator porphyria* (Verco, 1896). Backstairs Passage, Investigators Straits, 15 - 20 fathoms (27 - 37 metres); length 10.0mm, width 5.75mm (from Verco, 1896, pl. 8, fig. 5) (shell and operculum).

Fig. 14. *P.porphyria* (Verco, 1896). Between Spirits Bay and Three Kings Islands, New Zealand, 95 metres (52 fathoms); Powell coll., AIM, length 6.8mm, width 3.9mm (forma *coma* Odhner, 1924).

Fig. 15. *P.hedleyi* (Murdoch, 1905). Whangarei Heads, New Zealand; holotype DM M-1737, length 5.3mm, width 2.7mm (possibly a slender form of *P.porphyria* Verco, 1896).

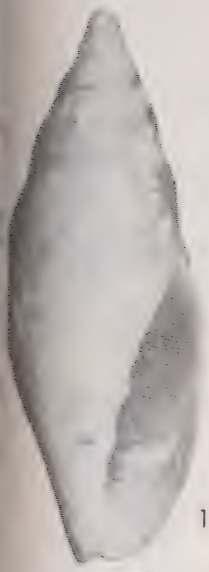
Fig. 16. *P.hedleyi* (Murdoch, 1905). Whangaroa Harbour, New Zealand; AIM, length 6.6mm, width 3.5mm.

Fig. 17. *P.verconis* Iredale, 1924. Twofold Bay, N.S.W., Australia, 15 - 28 fathoms (27 - 51 metres); holotype AM C-65643, length 11.0mm, width 5.8mm. Type species of *Peculator* Iredale, 1924.

Fig. 18. *P.obconicus* (Powell, 1952). Off Spirits Bay, Northland, New Zealand, 59 metres (32 fathoms); paratype Powell coll., AIM, length 6.4mm, width 3.4mm (part of siphonal canal missing).

Fig. 19. *P.clifdenensis* (Finlay, 1930). Clifden, Southland, M. Miocene of New Zealand; holotype AIM TM-589, length 5.2mm, width 2.6mm.

Fig. 20. *P.cassida* (Tate, 1889). Upper beds at Bird Rock, Victoria, Lower Miocene of Australia; Finlay coll., AIM, length 6.6mm, width 3.4mm.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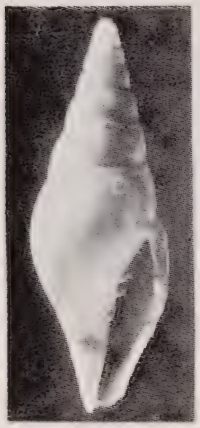
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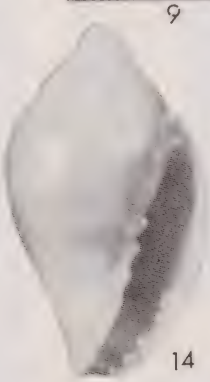
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PLATE 15

Fig. 1. *Microvoluta australis* Angas, 1877. Off Cronulla, N.S.W., Australia, 40 - 100 metres (22 - 55 fathoms), CSIRO; AM; length 8.8mm, width 3.8mm. Type species of *Microvoluta* Angas, 1877.

Fig. 2. *M.australis* Angas, 1877. Off Cronulla, N.S.W., Australia, 40 - 100 metres (22 - 55 fathoms), CSIRO; AM, length 7.7mm, width 3.0mm.

Fig. 3. *M.australis* Angas, 1877. Cape Pillar, Tasmania, 100 fathoms (183 metres); holotype of *M.purpureostoma* Hedley & May, 1908, AM C-29064, length 6.4mm, width 2.9mm (juvenile specimen).

Fig. 4. *M.complanata* (Tate, 1889). Adelaide bore, Sth. Australia, Pliocene of Australia; length 8.0mm, width 3.5mm (from Tate, 1889, pl. 5, fig. 12).

Fig. 5. *M.subcrenularis* (Tate, 1889). Adelaide bore, Sth. Australia, Pliocene of Australia; length 11.0mm, width 4.5 mm (from Tate, 1889, pl. 5, fig. 6).

Fig. 6. *M.intermedia* (Dall, 1890). St. 164B, "off Sydney", 410 fathoms (750 metres) [locality error ! = Caribbean]; syntype of *Mitra miranda* E. A. Smith, 1891, BMNH 1889.10.12.17, length *c.* 9.0mm.

Fig. 7. *M.intermedia* (Dall, 1890). Off St. Barthelémy, Guadaloupe Island, in sand, 496 fathoms (908 metres), at 44.4°F (7°C); holotype USNM 97102, length 15.0mm, width 5.7mm, height of aperture 7.5mm.

Fig. 8. *M.teretiuscula* (Thiele, 1925). Sta. 104, Agulhas Banks, Sth. Africa, 155 metres (85 fathoms); length 8.0 mm, width 3.0mm (from Thiele, 1925, pl. 20, fig. 23).

Fig. 9. *M.hottentotta* (Thiele, 1925). Sta. 104, Agulhas Banks, Sth. Africa; length 7.5mm, width 3.1mm (from Thiele, 1925, pl. 20, fig. 24).

Fig. 10. *M.joloensis* Cernohorsky, 1970—slender, costate form. Sta. 5423, off Cagayan I., Jolo Sea, Philippine Islands, in grey mud and sand, 508 fathoms (930 metres), at 49.8°F (10°C), U.S. Bureau of Fisheries; holotype USNM 288396, length 9.5mm, width 3.4mm.

Fig. 11. *M.joloensis* Cernohorsky, 1970—broad, obscurely costate form. Off Apo I., Sth. Negros, Philippine Islands, 256 fathoms (468 metres), U.S.B.F.; paratype USNM 290189, length 9.3mm, width 4.0mm.

Fig. 12. *M.joloensis* Cernohorsky, 1970—slender, smooth form. Iligan Bay, Nth. Mindanao, Philippine Islands, 445 fathoms (814 metres), U.S.B.F.,; paratype USNM 290450, length 8.6mm, width 3.4mm.

Fig. 13. *M.royana* Iredale, 1924. Off Green Cape, N.S.W., Australia, 50 - 70 fathoms (92 - 128 metres); holotype AM C-67279, length 9.9mm, width 4.0mm, height of aperture 4.5mm.

Fig. 14. *M.marginata* (Hutton, 1885). Wanganui, U. Pleistocene of New Zealand; lectotype CM M-3149, length 6.1 mm, width 2.8mm.

Fig. 15. *M.marginata* (Hutton, 1885). Wanganui, U. Pleistocene of New Zealand; paralectotype CM M-3150, length 7.4mm, width 3.0mm (part of siphonal canal worn).

Fig. 16. *M.marginata* (Hutton, 1885). Petane, L. Pleistocene of New Zealand, A. Hamilton coll.; holotype of *Turricula lincta* Hutton, 1885, CM M-3386, length 4.7mm, width 2.5mm (juvenile specimen).

Fig. 17. *M.marginata* (Hutton, 1885). Off Cuvier Island, New Zealand, 38 fathoms (70 metres); holotype of *M.cuvierensis* Finlay, 1930, AIM TM-473, length 6.2mm, width 2.7mm.

Fig. 18. *M.marginata* (Hutton, 1885). Between Waewaetorea and Motukiekie Islds., Bay of Islands, New Zealand, in sand, 8 fathoms (15 metres), leg. J. Hancock; length 7.0mm, width 3.0mm (forma *biconica* Murdoch & Suter, 1906).

Fig. 19. *M.marginata* (Hutton, 1885)—obscurely sculptured form. Between Waewaetorea and Motukiekie Islds., Bay of Islands, New Zealand, in sand, 8 fathoms (15 metres), leg. J. Hancock; length 6.2mm, width 3.0mm.

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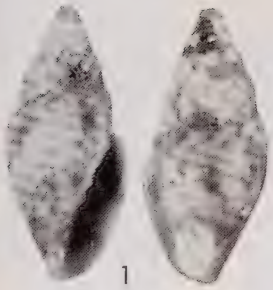
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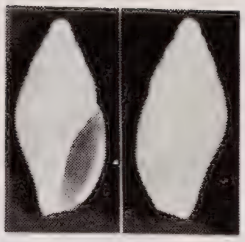
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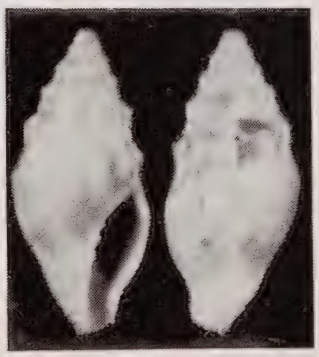
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PLATE 16

Fig. 1. *Microvoluta marginata* (Hutton, 1885). Off Aldermen Islands, New Zealand, 200 - 300 fathoms (366 - 549 metres), leg. C. Wormald ex-Valkyrie; length 7.1mm, width 3.2mm (internally lirate specimen).

Fig. 2. *M.marginata* (Hutton, 1885). Poor Knights Islands, New Zealand, 180 - 240 fathoms (329 - 439 metres), leg. C. Wormald ex-Valkyrie; length 6.6mm, width 3.1mm (internally lirate specimen).

Fig. 3. *M.vetusta* Laws, 1936. Kaawa Creek, Port Waikato, L. Pliocene of New Zealand; holotype length 9.0mm, width 4.0mm (from Laws, 1936, pl. 17, fig. 74) (internally lirate specimen).

Fig. 4. *M.blakeana* (Dall, 1889). Off Havana, Cuba, 80 - 300 fathoms (164 - 549 metres); holotype of *Conomitra blakeana* var. *laevior* Dall, 1889, USNM 86969, length 9.3mm, width 4.8mm.

Fig. 5. *Waimatea inconspicua* (Hutton, 1885). McCullough's bridge, Waihao, Sth. Canterbury, U. Eocene of New Zealand; AIM, length 18.2mm, width 7.4mm. Type species of *Waimatea* Finlay, 1927.

Fig. 6. *W.inconspicua* (Hutton, 1885). Waihao River, Sth. Canterbury, M. Eocene of New Zealand; holotype of *Vexillum apicicostatum* Suter, 1917, NZGS, length 11.6mm, width *c.* 5.2mm (immature specimen).

Fig. 7. *W.amplexa* Finlay, 1930. Waihao River, Waihao Downs, Sth. Canterbury, M. Eocene of New Zealand; holotype AIM TM-846, length 10.3mm, width 3.9mm.

Fig. 8. *W.parki* (Allan, 1926). McCullough's bridge, Waihao, Sth. Canterbury, U. Eocene of New Zealand; paratype AIM TM-1283, length 12.0mm, width 4.9mm.

Fig. 9. *W.parki* (Allan, 1926). McCullough's bridge, Waihao, Sth. Canterbury, U. Eocene of New Zealand; paratype AIM TM-1283, length 9.7mm, width 4.0mm.

Fig. 10. *W.incisa* (Marwick, 1942). Hampden beach, N.E. Otago, M. Eocene of New Zealand; length 16.0mm, width 6.5mm (from Marwick, 1942, pl. 25, fig. 29). Type species of *Compsomitra* Marwick, 1942 = *Waimatea* Finlay, 1927.

Fig. 11. *W.obscura* (Hutton, 1873). Syntype of *Mitra pica* Reeve, 1845, BMNH 1967838, length 17.2mm, width 7.8mm.

Fig. 12. *W.obscura* (Hutton, 1873). Off Hobart, Tasmania, Australia, leg. K. Duffy; length 17.7mm, width 8.5mm.

Fig. 13. *W.obscura* (Hutton, 1873). Sth. end of Poor Knights Islands, New Zealand, 5 - 10 fathoms (9 - 18 metres), leg. W. Palmer; length 20.0mm, width 9.0mm.

Fig. 14. *W.obscura* (Hutton, 1873)—costate form. Sth. end of Poor Knights Islands, New Zealand, 5 - 10 fathoms (9 - 18 metres), leg. W. Palmer; length 15.0mm, width 7.8mm (forma *mortenseni* Odhner, 1924).

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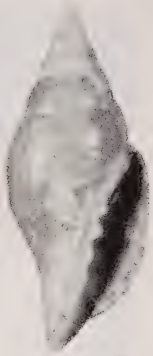

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PLATE 17

Fig. 1. *Waimatea enysi* (Hutton, 1873). Broken River, U. Oligocene of New Zealand; holotype NZGS, length 19.7 mm, width 8.4mm.

Fig. 2. *W.othone* (Tenison-Woods, 1880). Mornington, Balcombe Bay, Victoria, M. Miocene of Australia; AIM, length 11.6mm, width 5.7mm (immature specimen).

Fig. 3. *W.othone* (Tenison-Woods, 1880). Upper beds at Bird Rock, Victoria, L. Miocene of Australia; AIM, length 17.0mm, width 8.8mm (gerontic specimen).

Fig. 4. *W.othone* (Tenison-Woods, 1880). Target Gully, Oamaru, Otago, L. Miocene of New Zealand; holotype of *Conomitra othoniana* Finlay, 1924, AIM, TM-199, length 13.6mm, width 6.1mm.

Fig. 5. *W.othone* (Tenison-Woods, 1880). Target Gully, Oamaru, Otago, L. Miocene of New Zealand; paratype of *Conomitra othoniana* Finlay, 1924, AIM, TM-199, length 12.4mm, width 5.7mm.

Fig. 6. *W.othone* (Tenison-Woods, 1880). Otiake, Waitaki Valley, Otago, L. Miocene of New Zealand; holotype of *W.transilis* Finlay, 1930, AIM TM-847, length 11.0mm, width 5.3mm.

Fig. 7. *W.othone* (Tenison-Woods, 1880). Otiake, Waitaki Valley, Otago, L. Miocene of New Zealand; paratype of *W.transilis* Finlay, 1930, AIM TM-847, length 11.3mm, width 5.3mm.

Fig. 8. *Proximitra*(*Proximitra*)*rutidoloma* ,Suter, 1917). Ardgowan, Oamaru, L. Miocene of New Zealand; AIM, length 31.7mm, width 13.8mm. Type species of *Proximitra* Finlay, 1927.

Fig. 9. *P.*(*P.*)*rutidoloma* (Suter, 1917). Foot of Mount Horrible, L. Miocene of New Zealand, coll. M. C. Gudex; holotype CM M-3140, length 29.7mm, width 12.8mm.

Fig. 10. *P.*(*P.*)*apicalis* (Hutton, 1873). Awamoa, L. Miocene of New Zealand; holotype NZGS, length 11.4mm, width 4.3mm.

Fig. 11. *P.*(*P.*)*apicalis* (Hutton, 1873). Pukeuri, Oamaru, L. Miocene of New Zealand; AIM 13513, length 12.7mm, width 4.4mm.

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PLATE 18

Fig. 1. *Proximitra(Proximitra)apicalis* (Hutton, 1873). Blue Cliffs, Otaio River, Sth. Canterbury, L. Miocene of New Zealand; paratype of *P.partinoda* Finlay, 1930, AIM TM-640, length 9.4mm, width 4.0mm.

Fig. 2. *P.(P.)balteata* (Marwick, 1931). Akiripuraho Stream, Whaingaromia, Gisborne District, M. Miocene of New Zealand; length 7.3mm, width 3.8mm (from Marwick, 1931, pl. 13, fig. 246). Type species of *Vexillitra* Marwick, 1931 = *Proximitra* Finlay, 1927.

Fig. 3. *P.(P.)tumens* Finlay, 1930. Pukeuri, Oamaru, Otago, L. Miocene of New Zealand; paratype AIM, TM-642, length 11.8mm, width 4.9mm.

Fig. 4. *P.(P.)apalachee* (Gardner, 1937). Baileys Ferry, Chipola River, L. Miocene of Florida; length 24.8mm, width 10.5mm (from Gardner, 1937, pl. 48, fig. 36).

Fig. 5. *P.(P.)atractoides atractoides* (Tate, 1889). Grice's Creek, Victoria, Miocene of Australia; AIM, length 15.0 mm, width 5.8mm.

Fig. 6. *P.(P.)atractoides armorica* (Suter, 1917). Blue Cliffs, Sth. Canterbury, L. Miocene of New Zealand; AIM, length 21.8mm, width 8.1mm.

Fig. 7. *Proximitra(Parvimitra)paucinoda* Finlay, 1930. Blue Cliffs, Otaio River, Sth. Canterbury, L. Miocene of New Zealand; holotype AIM TM-641, length 11.4mm, width 5.3mm.

Fig. 8. *P.(P.)pukeuriensis* (Finlay, 1930). Pukeuri, Oamaru, Otago, L. Miocene of New Zealand; holotype AIM, TM-591, length 6.8mm, width 3.3mm. Type species of *Parvimitra* Finlay, 1930.

Fig. 9. *P.(P.)pukeuriensis* (Finlay, 1930). Target Gully, Oamaru, Otago, L. Miocene of New Zealand; holotype of *Parvimitra scopi* Finlay, 1930, AIM TM-592, length 6.4mm, width 3.2mm.

Fig. 10. *P.(P.)pukeuriensis* (Finlay, 1930). Ardgowan, Oamaru, Otago, L. Miocene of New Zealand; holotype of *Parvimitra ponsatanae* Finlay, 1930, AIM, TM-590, length 7.5mm, width 3.5mm.

Fig. 11. ?*Volutomitra(Latiromitra* ?)*bairdii* (Dall, 1889). 100 miles S.E. by S. from Cape Fear, Nth. Carolina, N.W. Atlantic, yellow mud, 528 fathoms (966 metres), at 38.7°F (4°C), ex-Albatross; holotype USNM 86962, length 34.2mm, width 8.6mm.

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BIBLIOGRAPHY

ADAMS, Arthur

1853. Descriptions of fifty-two new species of the genus *Mitra*, from the Cumingian collection. *Proc. Zool. Soc. Lond.* 1851, pt. 19: 132 - 141.

1853b. Descriptions of several new species of *Murex, Rissoina, Planaxis,* and *Eulima,* from the Cumingian collection. *Proc. Zool. Soc. Lond.* 1851, pt. 19: 267 - 272.

1855. Descriptions of thirty-nine new species of shells, from the collection of Hugh Cuming, Esq. *Proc. Zool. Soc. Lond.* 1854, pt. 22: 130 - 138.

1862. On some new species of Molluscs from Japan. *Ann. Mag. Nat. Hist.* (3) 9: 295 - 298.

1864. On the species of Mitridae found in the seas of Japan. *J. Linn. Soc. Lond.* 7: 198 - 201.

ADAMS, Charles Baker

1845. Specierum novarum conchyliorum, in Jamaica repertorum, synopsis. *Proc. Boston Soc. Nat. Hist.* 2: 1 - 17.

1852a. Notes on the synonymy of certain marine shells. *Contrib. Conchology,* No. 4: 54 - 55.

1852b. Descriptions of supposed new species of Marine Shells, which inhabit Jamaica. *Contrib. Conchology,* No. 4: 56 - 68.

1852c. Catalogue of shells collected at Panama with notes on synonymy, station and habitat. *Ann. Lyc. Nat. Hist. New York* 5: 229 - 548.

ADAMS, Henry

1869. Descriptions of a new genus and fourteen new species of marine shells. *Proc. Zool. Soc. Lond.* 1869: 272 - 275; pl. 19.

1872. Further descriptions of new species of shells, collected by Robert M'Andrew, Esq., in the Red Sea. *Proc. Zool. Soc. Lond.* 1872, pt. 1: 9 - 12; pl. 3.

ADAMS, Arthur and Lovell REEVE

1848-1850. *The Zoology of the voyage of H.M.S. Samarang; under the command of Captain Sir Edward Belcher during the years* 1843-1846. *Mollusca.* London, pt. 1: 1 - 24; pls. 1 - 9 (1848); pt. 2: 25 - 44; pls. 10 - 17 (1850); pt. 3: 45 - 78; pls. 18 - 24 (1850).

ADAMS, Henry and Arthur

1853. *The genera of Recent Mollusca; arranged according to their organization.* (Mitridae only). London, 1: 167 - 181.

AGUAYO, C. G. and H. A. REHDER

1936. New marine molluscs from Cuba. *Mem. Soc. Cubana Hist. Nat.* 9 (4): 263 - 268; pl. 24.

ALDRICH, T. H.

1886. Preliminary report upon the Tertiary fossils of Alabama and Mississippi. *Geol. Surv. Alabama Bull.* No. 1: 18 - 60; pls. 1 - 6.

1894. New Tertiary fossils from Red Bluff, Mississippi. *The Nautilus* 7 (9): 97 - 99; pl. 4.

ALLAN, Robin S.

1926. Fossil Mollusca from the Waihao Greensands. *Trans. N.Z. Inst.* 56: 338 - 346; pls. 76 - 77.

1927. The geology and paleontology of the lower Waihao Basin, South Canterbury, New Zealand. *Trans. N.Z. Inst.* 57: 265 - 309; textfigs.

ALTENA, C. O. VAN REGTEREN

1939. Notes on Caenozoic and Recent Mollusca from the Dutch East Indies, 3. *Basteria,* 4 (3/4): 46; pl. 3.

ALTH, Alois

1850. Geognostisch-palaeontologische Beschreibung der naechsten Umgebung von Lemberg. *Naturw. Abh. k. k. Akad. Wiss.* 3: 171 - 284; pls. 9 - 13.

ANDERSON, Frank M. and G. Dallas HANNA

1925. Fauna and stratigraphic relations of the Tejon Eocene at the type locality in Kerr County, California. *Occ. Pap. California Acad. Scien.* 11: 1 - 249; pls. 1 - 16.

ANGAS, George French

1867. Descriptions of thirty-two new species of marine shells from the coast of New South Wales. *Proc. Zool. Soc. Lond.* 1867: 110 - 117; pl. 13.

1877. Descriptions of two genera and twenty species of marine shells from New South Wales. *Proc. Zool. Soc. Lond.* 1877: 34 - 40; pl. 5.

1878. Descriptions of nine new species of land and marine shells from various localities. *Proc. Zool. Soc. Lond.* 1878: 311 - 314; pl. 18.

1879. Descriptions of ten species of marine shells from the Province of South Australia. *Proc. Zool. Soc. Lond.* 1878, pt. 4: 861 - 864; pl. 54.

ANTON, Hermann Eduard

1839. *Verzeichniss der Conchylien welche sich in der Sammlung von Hermann Eduard Anton befinden.* Halle, pp. i - xvi; 1 - 110.

AZUMA, Masao

1965a. Description of a new mitrid species with some remarks on Japanese shells. *Venus: Japan. J. Malac.* 23 (4): 177 - 181; textfigs.

1965b. On the radulae of the family Vexillidae. *Venus: Japan J. Malac.* 24 (1): 53 - 57; pl. 5.

BALDI, T., T. KECSKEMETI, M. R. NYIRÖ and C. W. DROOGER

1961. Neue Angaben zur Grenzziehung zwischen Chatt und Aquitan in der Umgebung von Eger (Nordungarn). *Ann. Hist.-Nat. Mus. Nat. Hungary* 53: 67 - 131; pls. 1 - 4.

BARNARD, Keppel Harcourt

1959. Contributions to the knowledge of South African marine Mollusca. Part II. Gastropoda:Prosobranchiata: Rhachiglossa. *Ann. Sth. African Mus.* 45 (1): 1 - 237; textfigs.

1960a. The genus *Charitodoron* Tomlin, 1932. *J. Conch.* 24 (11): 402.

1960b. New species of South African marine gastropods. *J. Conch.* 24 (12): 438 - 442; textfigs.

BARNES, D. H.

1824. Notice of several species of shells. *Ann. Lyc. Nat. Hist. New York* 1: 131 - 140; pl. 9.

BARTSCH, Paul

1915. Report on the Turton collection of South African marine Mollusks, with additional notes on other South African shells contained in the United States National Museum. *Bull. U.S. Nat. Mus.* 91: 1-305; pls. 1-54.

1918. New marine mollusks from the Philippine Islands. *Proc. Biol. Soc. Washington* 31: 181 - 187.

1919. Notes. *The Nautilus* 33 (1): 31.

1931. Descriptions of new marine Mollusks from Panama, with a figure of the genotype of *Engina*. *Proc. U.S. Nat. Mus.* 79 (15): 1 - 10; pl. 1.

BAUDON, M. Auguste

1853. Description de coquilles fossiles de Saint-Félix (Oise), avec une notice sur les terrains de cette localité. *J. Conchyl.* 4: 321 - 333; pl. 9.

BAYER, Ted

1942. Observations on *Mitra florida* Gould. *The Nautilus* 55 (3): 78 - 80; pl. 7.

BEETS, C.

1941. Eine Jungmiocäne Mollusken-Fauna von der Halbinsel Mangkalihat, Ost-Borneo. *Verh. geolog. Mijnb. Genoot. Ned. & Kolon.* 13 (1): 1 - 219; pls. 1 - 9.

1943. Beiträge zur Kenntnis der angeblich Oberoligozänen Mollusken-Fauna der Insel Buton, Niederländisch-Ostindien. *Leidsche Geolog. Meded.* 13: 256 - 328.

1950. Oligozäne und wahrscheinlich Miozäne Gastropoden aus dem Peel-Gebiete (Südliche Niederlande). *Meded. Geol. Sticht.* ser. C, 4 (8): 1 - 78; pls. 1 - 4.

BELLARDI, Luigi

1850. Monografia delle Mitre fossili del Piemonte. *Mem. Real. Accad. Sci. Torino* ser. 2, 11: 1 - 34 (in reprint); pls. 1 - 2.

1887-1888. I molluschi dei terreni Terziarii del Piemonte e della Liguria. *Mem. Real. Accad. Sci. Torino* 38: 79 - 166; pls. 1 - 2 (Parte V—fasc. 1). 38: 257 - 326; pls. 3 - 4 (Parte V—fasc. 2)—1887. 39: 145 - 194; pls. 5 - 6 (Parte V—fasc. 3)—1888.

BERNARDI, M.

1853. Description de deux coquilles nouvelles. *J. Conchyl.* 4: 67 - 69; pl. 2.

BERRY, Samuel Stillman

1920. On *Mitra montereyi*, a new Californian species. *Proc. Malac. Soc. Lond.* 14 (1): 31 - 33; textfigs.

1957. Notices of new Eastern Pacific Mollusca.—I. *Leafl. Malac.* 1 (14): 75 - 82.

1958. West American molluscan Miscellany—II. Proposal of five new generic taxons. *Leafl. Malac.* 1 (16): 91 - 98.

1960. Notices of new Eastern Pacific mollusca.—IV. *Leafl. Malac.* 1 (19): 115 - 122.

BINKHORST, J. T.

1861. *Monographie des Gastéropodes et des Céphalopodes de la Craie Supérieure du Limbourg.* Bruxelles & Maestricht, pp. i - vi; 1 - 83; pls. 1 - 6 (Gastéropodes); pp. 1 - 44; pls. 5b - 9 (Céphalopodes).

BEU, Alan G.

1967. Deep-water Pliocene Mollusca from Palliser Bay, New Zealand. *Trans. Roy. Soc. N.Z. Geol.* 5 (3): 89 - 122; pls. 1 - 2; textfigs.

Beyrich, E.

1854. Die Conchylien des norddeutschen Tertiärgebirges. *Zeit. Deutschen geol. Gesell.* 6 (2): 408 - 500; pls. 9 - 14 (6 - 11). [Plate 8 (5) cited in this work has appeared in Vol. 5—1853].

Bezancon, A.

1870. Description d'espèces nouvelles du Bassin de Paris. *J. Conchyl.* 18: 310 - 323.

Blainville, Henri Marie Ducrotay de

1828-1830. *Faune Francaise ou Histoire naturelle générale et particulière des animaux qui se trouvent en France.* Paris, pp. 1 - 320; 41 pls. (pp. 161 - 240 in livr. 23—1829).

Boettger, Otto

1875. Die fossilen Mollusken der Eocänenformation auf der Insel Borneo. *Paläontographica Suppl.* 3 (1): 9 - 59; pls. 1 - 10.

1883. Die Mollusken der oligocänen Schichten vom Bawang-Flusse, Res. Djokdjakarta, Insel Java. *Paläontographica Suppl.* 3 (9/10): 125 - 148; pls. 1 - 2.

1902-1907. Zur Kenntnis der Fauna der mittelmiocänen Schichten von Kostej im Krassó-Szörényer Komitat. *Verh. Mitt. Siebenbürgischen Ver. Naturw. Herm.* 51: 1 - 200 (1902); 54: 1 - 99 (1906); 55: 101 - 244 (1907).

Born, Ignatz von

1778. *Index rerum naturalium Musei Caesarei Vindobonensis; pars* I. *Testacea.* Vienna, pp. i - xlii; 1 - 458.

1780. *Testacea Musei Caesarei Vindobonensis.* Vienna, pp. i - xxxvi; 1 - 442; 18 pls.

Brann, Doris and Lois S. Kent

1960. Catalogue of the type and figured specimens in the Palaeontological Research Institution. *Bull. Amer. Paleont.* 40 (184): 1 - 985.

Briart, A. and F. L. Cornet

1871. Description des fossiles du Calcaire grossier de Mons. *Mém. Acad. Roy. Sci. Lett. Art. Belgique* 36: 1 - 76; pls. 1 - 5.

Brocchi, Giovanni Battista

1814. *Conchiologia fossile subappenina con osservazioni geologiche sugli apennini e sula suolo adiacente.* Milano, 1: i - lxxx; 1 - 56; 1 - 240; 2: 241 - 712; pls. 1 - 16.

Broderip, William John

1836. Characters of new genera and species of Mollusca and Conchifera collected by Mr. Cuming. *Proc. Zool. Soc. Lond.* 1835: 192 - 197.

Brookes, Albert E.

1926. New species of Recent Mollusca. *Trans. N.Z. Inst.* 56: 588 - 590; pl. 102.

Brown, Amos P. and Henry A. Pilsbry

1911. Fauna of the Gatun formation, Isthmus of Panama. *Proc. Acad. Nat. Sci. Philadelphia* 63: 336 - 373; pls. 22 - 29.

1913. Fauna of the Gatun formation, Isthmus of Panama, II. *Proc. Acad. Nat. Sci. Philadelphia* 64: 500 - 519; pls. 22 - 26; textfigs.

Bucquoy, Eugène, Philippe Dautzenberg and Gustave Frédéric Dollfus

1882-1883. *Les mollusques marins du Roussillon. Pleurotominae, Volutidae & Cypraeadae.* Paris, 1: 85 - 135; pls. 11 - 15.

Buonanni, Filipo

1684. *Ricreatione dell' occhio e della mente nell' osservation delle Chiocciole.* Rome, pts. 1 - 4; i - xiv; 1 - 384; 109 pls.

Cantraine, Francois Joseph

1835. Les diagnoses ou descriptions succinctes de quelques espèces nouvelles de mollusques. *Bull. Acad. Roy. Sci. Bruxelles* 2: 380 - 401.

Carcelles, Alberto R.

1947. *Notas sobre algunos Gastrópodos marinos del Uruguay y la Argentina,* I - VI. *Commun. Zool. Mus. Hist. Nat. Montevidea* 2 (40): 1 - 27; pls. 1 - 7; textfigs.

Carcelles, Alberto R. and Susana I. Williamson

1951. Catalogo de los Moluscos marinos de la Provincia Magallanica. *Rev. Inst. Nac. Inv. Cien. Nat. Argentina* 2 (5): 225 - 383.

Cate, Jean M.

1960. Range extension and synonymy for *Mitra nigra* (Schröter, 1788). *The Veliger* 3 (2): 49 - 51.

1961a. A new *Vexillum* (Mitridae) from the Philippine Islands. *The Veliger* 4 (1): 4 - 8; pls. 1 - 2.

1961b. A discussion of *Vexillum regina* (Sowerby, 1825) and related species, with description of a new subspecies. *The Veliger* 4 (2): 76 - 85; pls. 18 - 20.

1962a. On the identifications of five Pacific *Mitra*. *The Veliger* 4 (3): 132 - 134; pl. 29.
1962b. Revision of some Hawaiian mitrid species. *The Veliger* 4 (3): 140 - 149; pls. 33 - 35.
1962c. Observations on three species of *Vexillum* (Gastropoda). *The Veliger* 4 (4): 184 - 191; pls. 41 - 44.
1962d. A new species of *Mitra* (Gastropoda) from Hawaii. *The Veliger* 5 (2): 80 - 83; pls. 10 - 11.
1963. Revision of Dall's Hawaiian mitrids with descriptions of three new species (Mollusca: Gastropoda). *The Veliger* 6 (1): 23 - 43; pls. 5 - 8.
1964. A new species of *Mitra* from the Western Indian Ocean (Mollusca: Gastropoda). *The Veliger* 6 (4): 219; pl. 28.
1966. A new name for *Mitra sanguinolenta* Lamarck, 1811. *The Veliger* 9 (2): 239 - 241; pl. 23.
1967a. *Mitra prosanguinolenta* J. Cate, 1966 relegated to synonymy. *The Veliger* 9 (4): 442.
1967b. The radulae of nine species of Mitridae. *The Veliger* 10 (2): 192 - 195; pl. 19; textfigs.
1968a. Mating behaviour in *Mitra idae* Melvill, 1893. *The Veliger* 10 (3): 247 - 252; textfigs.
1968b. Five new species of Mitridae from the Indian and Pacific Oceans. *The Veliger* 11 (2): 85 - 89; pl. 11.

Cernohorsky, Walter O.

1965a. *Voluta pertusa* Linnaeus, 1758; *Voluta morio* Linnaeus, 1767; *Voluta ruffina* Linnaeus, 1767; *Bulla conoidea* Linnaeus, 1767 (Mollusca, Gastropoda): proposed suppression under the plenary powers Z.N. (S.) 1700. *Bull. zool. Nomencl.* 22 (3): 198 - 203.
1965b. The Mitridae of Fiji. *The Veliger* 8 (2): 70 - 160; pls. 13 - 23.
1966a. Radulae of four species of Mitridae. *J. Conch.* 26: 15 - 18; textfigs.
1966b. The mitrid genera and species established by P. F. Röding in the "Museum Boltenianum". *J. Conch.* 26: 89 - 98.
1966c. Comments on the proposed validation of *Voluta episcopalis* Linnaeus, 1758. Z.N. (S.) 1728. *Bull. zool. Nomencl.* 23 (2/3): 80 - 81.
1966d. A study of mitrid radulae and a tentative generic arrangement of the family Mitridae (Mollusca: Gastropoda). *The Veliger* 9 (2): 101 - 126; textfigs.
1966e. Die Radula-Platten einiger wenig bekannter Prosobranchier (Mollusca-Gastropoda). *Arch. Mollusk.* 95 (5/6): 275 - 277; textfigs.
1967a. *Voluta citrina* Gmelin, 1791; *V. strigosa* Gmelin, 1791; *V. leucostoma* Gmelin, 1791 (Gastropoda): proposed suppression under the plenary powers. Z.N. (S.) 1777. *Bull. zool. Nomencl.* 24 (1): 53 - 54.
1967b. Name change for a Pacific and Hawaiian *Vexillum* species (Mitridae). *Hawaiian Shell News* 15 (4): 6 - 7; textfig.
1967c. A note on three species of Mitridae (Mollusca: Gastropoda). *The Veliger* 9 (4): 441 - 442.
1967d. The species of Mitridae established by J. F. Gmelin in the "Systema Naturae" of 1791. *J. Conch.* 26: 161 - 174.
1967e. *Marine Shells of the Pacific*. Sydney, pp. 1 - 248; pls. 1 - 60; textfigs.
1968a. The species of Mitridae established by H. F. Link in the Rostock Catalogue. *J. Conch.* 26: 215 - 218.
1968b. The date of publication of Kiener's *Mitra* monograph in the "Spécies général et iconographie des coquilles vivantes". *The Veliger* 10 (4): 349.
1969a. Type specimens of Mitridae (Mollusca: Gastropoda) described by Linnaeus in the genera *Voluta, Buccinum* and *Bulla* between 1758 and 1771. *J. Linn. Soc. Lond. Zool.* 48: 351 - 362; pls. 1 - 2.
1969b. The taxonomy of Hawaiian and Indo-Pacific Mitridae — Part I. *Hawaiian Shell News* 17 (12): 1; textfigs.
1969c. The types of the Lamarck collection in the Museum d'Histoire Naturelle in Geneva. Recent Mollusca of the genera *Mitra, Columbella* (part) and *Cancellaria* (part). *Rev. suisse Zool.* 76 (50): 953 - 994; pls. 1-7.
1970a. New Mitridae and Volutomitridae. *The Nautilus* 83 (3): 95 - 104; textfigs.
1970b. The taxonomy of Hawaiian and Indo-Pacific Mitridae — Part II. *Hawaiian Shell News* (in press).

Chemnitz, Johann Hieronymus

1780-1795. *Neues systematisches Conchylien-Cabinet*. Nürnberg, Vol. 4 (1780); Vol. 10 (1788); Vol 11 (1795).

Clark, W. B. and G. C. Martin

1901. The Eocene deposits of Maryland. *Publ. Maryland Geol. Surv.* pp. 19 - 91; 122 - 205.

Clench, William J. and Ruth D. Turner

1950. The Western Atlantic Marine Mollusks described by C. B. Adams. *Occ. Pap. Moll. Harvard* 1 (15): 233 - 403; pls. 29 - 49.

Coan, Eugene

1966a. *Voluta mitra* Linnaeus, 1758, vs. *Voluta episcopalis* Linnaeus, 1758 (Mollusca: Gastropoda): Proposed use of plenary powers. Z.N. (S.) 1728. *Bull. zool. Nomencl.* 22 (5/6): 355 - 356.
1966b. Nomenclatural units in the gastropod family Mitridae. *The Veliger* 9 (2): 127 - 137.

Coen, Giorgio

1934. Recente rinvenimento adriatico della "*Mitra(Episcomitra)zonata*" Marryatt. *Nat. Inst. Biol. Mar. Rovigno* 12 (15): 3 - 5; textfigs.

Comella, J. F. de V.

1956. Los moluscos fossiles de Eocene Pirenaico. *Bol. Inst. geol. Espana* 67: 117 - 235.

CONRAD, Timothy Abbott

1840. New fossil shells from N. Carolina. *Amer. J. Scien.* 39 (2): 387 - 388.

1848a. Observations on the Eocene formation, and descriptions of one hundred and five new fossils of that period, from the vicinity of Vicksburg, Mississippi. *Proc. Acad. Nat. Sci. Philadelphia* new ser. 3: 280 - 299.

1848b. Observations on the Eocene formation, and descriptions of one hundred and five new fossils of that period, from the vicinity of Vicksburg, Mississippi; with an Appendix. *J. Acad. Nat. Sci. Philadelphia* new ser. 1 (2): 111 - 133; pls. 11 - 14.

1854. *Report on the Agriculture & Geology of Mississippi.* (in WAILES). State Printer E. Barksdale, pp. i - xx; 17 - 371; pls. 1 - 17.

1855. Observations on the Eocene deposit of Jackson, Mississippi, with descriptions of thirty-four new species of shells and corals. *Proc. Acad. Nat. Sci. Philadelphia* 7 (7): 257 - 263.

1863. Catalogue of the Miocene shells of the Atlantic slope. *Proc. Acad. Nat. Sci. Philadelphia* 14 (10/12): 559 - 583.

1865. Catalogue of the Eocene and Oligocene Testacea of the United States. *Amer. J. Conch.* 1 (1): 1 - 35.

COOKE, Alfred Hands

1920a. The radula of the Mitridae. *Proc. Zool. Soc. Lond.* 1919: 405 - 422; textfigs.

1920b. *Mitra burnupiana,* n.sp., from South Africa. *Proc. Malac. Soc. Lond.* 14: 114 - 115; textfigs.

COSSMANN, Alexandre Édouard Maurice

1881. Description d'espèces inedites du Bassin Parisien. *J. Conchyl.* 29: 167 - 173; pl. 7.

1882. Description d'espèces nouvelles du Basin parisien. *J. Conchyl.* 30: 114 - 130; pls. 5 - 6.

1885. Description d'espèces du Terrain tertiaire des environs de Paris. *J. Conchyl.* 33: 106 - 130; pls. 4 - 6; 33: 196 - 206; pl. 8.

1889. Catalogue illustré des coquilles fossiles de L'Éocène des environs de Paris. *Ann. Soc. Roy. Malac. Belgique* 24: 1 - 385; pls. 1 - 12.

1891. Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Supplément. *Ann. Soc. Roy. Malac. Belgique* 26: 1 - 166; pls. 1 - 3.

1893. Révision sommaire de la faune du terrain oligocène marin aux environs d'Étampes. *J. Conchyl.* 41: 297 - 363.

1896a. Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Appendice 2. *Ann. Soc. Roy. Malac. Belgique* 31: 1 - 94; pls. 1 - 3.

1896b. Mollusques Éocénique de la Loire-Inférieure. *Bull. Soc. Sci. Nat. L'Ouest France* 6 (4): 43 - 110 (179-246); pls. 4 - 9.

1898. Mollusques Éocénique de la Loire-Inférieure. Appendice au second fascicule. *Bull. Soc. Sci. Nat. L'Ouest France* 8 (1): 41 - 55; pl. 2 (18).

1899. *Essais de paléoconchologie comparée.* Paris, 3: 1 - 201; pls. 1 - 8; textfigs.

1901. Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Appendice 3. *Ann. Soc. Roy. Malac. Belgique* 36: 9 - 110; pls. 2 - 7.

1903. Faune pliocénique de Karikal (Inde Francaise), t. II. *J. Conchyl.* 51: 105 - 173; pls. 3 - 6.

1906. Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Appendice 4. *Ann. Soc. Roy. Malac. Belgique* 41: 186 - 286; pls. 5 - 10.

1909. *Essais de paléoconchologie comparée.* Paris, 8: 1 - 248; pls. 1 - 4; textfigs.

1913a. Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Appendice 5. *Ann. Soc. Roy. Malac. Belgique* 49: 19 - 238; pls. 1 - 8.

1913b. Étude comparative de fossiles miocéniques recueillis à la Martinique et à l'Isthme de Panama. *J. Conchyl.* 61: 1 - 64; pls. 1 - 5.

1921. Rectification de nomenclature. *Rev. Crit. Paléozool.* 25 (2): 79 - 80.

COSSMANN, A. E. M. and G. PISSARRO

1901. Faune Éocénique du Cotentin (Mollusques). *Bull. Soc. Geolog. Normandie* 20: 61 - 140; pls. 7 - 15.

COTTON, Bernard Charles

1957. No. 12: Family Mitridae. *Roy. Soc. Sth. Australia Malac. Sect.* pp. 1 - 7; 1 pl.

COTTON, Bernard C. and F. K. GODFREY

1932. South Australian shells (including descriptions of new genera and species). Part III. *Sth. Australian Nat.* 13 (2): 35 - 86; pls. 1 - 4.

COX, Leslie Reginald

1927. *Report on the Palaeontology of the Zanzibar Protectorate.* Govt. of Zanzibar Publ. pp. 1 - 180; pls. 1-23.

1930. *Vexillum(Uromitra)macfadyeni,* n.sp., from the Pleistocene of Kamaran Island (Red Sea). *Proc. Malac. Soc. Lond.* 19: 77 - 78; pl. 8a.

1931. A contribution to the molluscan fauna of the Laki and Basal Khirthar groups of the Indian Eocene. *Trans. Roy. Soc. Edinburgh* 57 (2): 25 - 92; pls. 1 - 4.

1936. Pliocene Mollusca from Portugal. *Mem. & Not. Mus. Min. & Geol. Univ. Coimbra* No. 9: 3 - 31; pls. 1-2.

1941. New species of Gastropoda from the Pliocene of Portugal. *Mem. Mus. Min. geol. Univ. Coimbra* No. 10: 7 - 12; pl. 1.

1948. Neogene Mollusca from the Dent Peninsula, British North Borneo. *Schweizer Paläont. Abh.* 66: 1 - 70; pls. 1 - 6.

CROSSE, Joseph Charles Hippolyte

1861. Diagnoses d'espèces nouvelles. *J. Conchyl.* 9: 285.

1862. Diagnose d'une Mitre nouvelle. *J. Conchyl.* 10: 253 - 255.

1867. Description d'espèces nouvelles des archipels Samoa et Viti. *J. Conchyl.* 15: 297 - 302; pl. 11.

1868. Description d'espèces nouvelles. *J. Conchyl.* 16: 268 - 276; pl. 9.

1872. Diagnoses Molluscorum Novae Caledoniae incolarum. *J. Conchyl.* 20: 69 - 75.

1878. Description d'une nouvelle espèce de Mitre, provenant du Japon. *J. Conchyl.* 26: 59 - 59; pl. 1.

CROSSE, J. C. H. and P. FISCHER

1864. Faune malacologique de Cochinchine.—Premier supplément. *J. Conchyl.* 12: 322 - 338; pls. 8, 12.

DALL, William Healey

1884. On a collection of shells sent from Florida by Mr. Henry Hemphill. *Proc. U.S. Nat. Mus.* 6 (384): 318-342; pl. 10.

1889a. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877-78) and in the Caribbean Sea (1879-80), by the U.S. Coast Survey steamer *Blake*, Lieut.-Commander C. D. Sigsbee, U.S.N., and Commander J. R. Bartlett, U.S.N. commanding. XXIX. Report on the Mollusca. Part II. Gastropoda and Scaphopoda. *Bull. Mus. Comp. Zool. Harvard* 18: 1 - 492; pls. 1 - 40.

1889b. A preliminary catalogue of the shell-bearing marine Molluscs and Brachiopods of the South-Eastern coast of the United States, with illustrations of many of the species. *Bull. U.S. Nat. Mus.* 37: 1 - 221; pls. 1 - 74.

1890. Scientific results of explorations by the U.S. Fish Commission Steamer *Albatross*. *Proc. U.S. Nat. Mus.* 12 (773): 219 - 362; pls. 5 - 14.

1890-1892. Contributions to the Tertiary Fauna of Florida, with special reference to the Miocene Silex-beds of Tampa and the Pliocene beds of the Caloosahatchie River. *Trans. Wagner Free Inst. Sci. Philadelphia* 3 (1): 1 - 199; pls. 1 - 12 (1890); 3 (2): 201 - 473; pls. 13 - 22 (1892).

1902. A new species of *Volutomitra*. *The Nautilus* 15 (9): 102 - 103.

1915. A monograph of the molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Florida. *Bull. U.S. Nat. Mus.* 90: 1 - 173; pls. 1 - 26.

1918. Changes in and additions to molluscan nomenclature. *Proc. Biol. Soc. Washington* 31: 137 - 138.

1920. A new species of *Mitra* from California. *The Nautilus* 33 (3): 103.

1921. Summary of the marine shell bearing Molluscs of the northwest coast of America, from San Diego, California, to the Polar Sea, mostly contained in the collection of the United States National Museum, with illustrations of hitherto unfigured species. *Bull. U.S. Nat. Mus.* 112: 1 - 217; pls. 1 - 22.

1924. On the value of nuclear characters in the classification of marine gastropods. *J. Washington Acad. Sci.* 14: 177 - 180.

1925. Illustrations of unfigured types of shells in the collection of the United States National Museum. *Proc. U.S. Nat. Mus.* 66 (17): 1 - 41; pls. 1 - 36.

1927. Small shells from dredgings off the South east coast of the United States by the United States Fisheries Steamer *Albatross* in 1885 and 1886. *Proc. U.S. Nat. Mus.* 70 (18): 1 - 134.

DAUTZENBERG, Philippe

1910. Contribution a la Faune malacologique de L'Afrique Occidentale. *Act. Soc. Linn. Bordeaux* 64: 1 - 174; pls. 1 - 4.

1929. Mollusques testacés marins de Madagascar. Mollusca II. *Faun. Colon. Francaise* 3: 321 - 636; pls. 4 - 7.

1932. Mollusques testacés marins de Madagascar. Supplément. *J. Conchyl.* 76: 5 - 119; pl. 1.

1935. Résultats scientifiques du voyage aux Indes Orientales Néerlandaises; Gast. Marins; Terebridae et Mitridae. *Mém. Mus. Roy. Hist. Nat. Belgique* 2 (17): 1 - 208; pls. 1 - 4.

DAUTZENBERG, P. and L. J. BOUGE

1923. Mitridés de la Nouvelle-Calédonie et de ses dependances. *J. Conchyl.* 67 (2): 83 - 159; 67 (3): 179 - 259; pl. 2.

1933. Les mollusques testacés marins des établissement Francais de l'Océanie. *J. Conchyl.* 77 (2): 145 - 326.

DELL, Robert K.

1951. A deep water molluscan fauna from off Banks Peninsula. *Rec. Canterbury Mus.* 6 (1): 53 - 60; pl. 1.

1956. The Archibenthal Mollusca of New Zealand. *Bull. Dom. Mus., Wellington* 18: 1 - 235; pls. 1 - 25; A-B.

DEMOND, Joan

1957. Micronesian reef-associated Gastropods. *Pacif. Sci.* 11 (3): 275 - 341; textfigs.

DESHAYES, Gérard Paul

1824-1837. *Description des coquilles fossiles des environs de Paris. Mollusques.* Paris, 2: 1 - 814 (pp. 499 - 780 = 1835); Atlas pp. 1 - 51; pls. 1 - 106 (1837).

1830-1832. *Encyclopédie méthodique: histoire naturelle des vers.* Paris, 2nd ed., 2 (2): 1 - 144 (1830): 145 - 594 (1832).

1865. *Description des animaux sans vertèbres découverts dans le Bassin de Paris.* Paris, 3: 1 - 668; Atlas 2: pls. 1 - 107.

DESHAYES, G. P. in E. J. de LABORDE and M. LINANT

1834. *Voyage de L'Arabie Pétrée.* Paris, pp. 1 - 87; unnumbered pls.

DESHAYES, G. P. and H. Milne EDWARDS
1835-1845. *Histoire Naturelle des Animaux sans vertèbres. Mollusca.* Paris, 2nd ed., Vols. 6 - 11 (Mitridae in Vol. 10 — 1844).

DICKERSON, Roy E.
1915. Fauna of the type Tejon: Its relations to the Cowlitz phase of the Tejon group of Washington. *Proc. California Acad. Sci.* 5 (3): 33 - 98; pls. 1 - 11.

DIETRICH, Richard V. and P. MORRIS
1953. Mollusks from Kwajalein. *The Nautilus* 67 (1): 13 - 18; pl. 4.

DILLWYN, Lewis Weston
1817. *A descriptive catalogue of Recent shells, arranged according to the Linnaean method.* London, 1: 1 - 580; pls. 1 - 5; 2: 581 - 1092; 1 - 29.

DODGE, Henry
1955. A historical review of the mollusks of Linnaeus, Part 3; the genera *Bulla* and *Voluta* of the class Gastropoda. *Bull. Amer. Mus. Nat. Hist.* 107 (1): 1 - 158..

DOHRN, Heinrich
1860a. Description of new species of *Mitra* from the collection of Hugh Cuming Esq. *Proc. Zool. Soc. Lond.* 1860, pt. 28: 366 - 368.
1860b. Zur Kenntnis einiger Arten des Genus *Mitra* Lamarck. *Malakozool. Blätt.* 7: 120 - 125.
1861a. Zur Kenntnis von *Mitra*. *Malakozool. Blätt.* 8: 133 - 139.
1861b. Descriptions of new shells from the collection of H. Cuming, Esq. *Proc. Zool. Soc. Lond.* 1861: 205 - 207; pl. 26.
1862. Descriptions of new shells. *Proc. Zool. Soc. Lond.* 1862: 202 - 203.

DUNKER, Guilielmo
1852. Diagnoses Molluscorum novorum. *Zeit. Malakozool.* 9 (4): 49 - 62.
1858-1870. *Novitates Conchologicae. Mollusca marina. Beschreibung und Abbildung neuer oder wening gekannter Meeres-Conchylien.* Cassel. pp. 1 - 144; pls. 1 - 45.
1860. Neue japanische Mollusken. *Malakozool. Blätt.* 6: 221 - 240.
1861. *Mollusca Japonica descripta et tabulis tribus iconum.* Stuttgart, pp. i - iv; 1 - 36; pls. 1 - 3.
1879. Mollusca quaedam nova. *J. Conchyl.* 27: 212 - 217; pls. 8 - 9.
1882. *Index molluscorum maris Japonici conscriptus et tabulis iconum* XVI *illustratus.* Cassel. pp. i - vii; 1 - 301; pls. 1 - 16.

DUVAL, M.
1852. Description d'une espèce nouvelle du genre Mitre. *J. Conchyl.* 3: 160 - 162; pl. 7.

EAMES, F. E.
1952. A contribution to the study of the Eocene in Western Pakistan and Western India. *Phil. Trans. Roy. Soc. Lond.* 236 (631): 1 - 168; pls. 1 - 6.

EDWARDS, Frederic E.
1856. A monograph of the Eocene Mollusca, or description of shells from the older Tertiaries of England. *Palaeont. Soc. England Mon.* pt. 3 (2): 180 - 240: pls. 24 - 27.

ENGERRAND, Jorge and F. URBINA
1910. Primera nota acerca de la fauna miocénica de Zuluzum (Chiapas). *Bol. Soc. Geol. Mexicana* 6 (2): 119-140; pls. 58 - 60.

FARGO, William G.
1948. New *Vexillum* and *Aesopus* from the Pliocene of St. Petersburg, Florida. *The Nautilus* 61 (4): 109 - 112; pl. 7.
1951. A new *Vexillum* from Pliocene of St. Petersburg, Florida. *The Nautilus* 64 (4): 121 - 122; pl. 10.

FINLAY, Harold John
1924a. Some necessary changes in names of New Zealand Mollusca. *Proc. Malac. Soc. Lond.* 16 (2): 99 - 107.
1924b. New shells from New Zealand Tertiary beds. *Trans. N.Z. Inst.* 55: 450 - 479; pls. 48 - 51.
1927a. A further commentary on New Zealand Molluscan Systematics. *Trans. N.Z. Inst.* 57: 320 - 485; pls. 18 - 23.
1927b. New specific names for Austral Mollusca. *Trans. N.Z. Inst.* 57: 488 - 533.
1930a. New shells from New Zealand Tertiary beds. Part 3. *Trans. N.Z. Inst.* 61: 49 - 84; pls. 1 - 6.
1930b. Additions to the Recent Molluscan Fauna of New Zealand. *Trans. N.Z. Inst.* 61: 222 - 247; pls. 42 - 45.

FISCHER, Paul Henri
1880-1887. *Manuel de Conchyliologie et de paléontologie conchyliologique ou histoire naturelle des mollusques vivants et fossiles.* Paris, pp. i - xxiv; 1 - 1369; pls. 1 - 23; textfigs. (Mitridae in fascicule 6: 552 - 553 — 1883, and fascicule 7: 610 - 614 — 1884).
1882. Diagnoses d'espèces nouvelles de Mollusques recueillis dans le cours des Expéditions scientifiques de l'aviso le Travailleur (1882). Pars II. *J. Conchyl.* 30: 273 - 277.

FISCHER, P. H. and R. TOURNOUER in A. GAUDRY

1873. *Invertèbres fossiles du Mont Léberon; in Animaux fossiles du Mont Léberon (Vaucluse)*. Paris, pp. 118-177; pls. 16 - 21.

FLEMING, Charles A.

1943. Tertiary Mollusca from Dannevirke Subdivision. *Trans. Roy. Soc. N.Z.* 73 (3): 193 - 208; pls. 28 - 31.

1958. On the supposed occurrence of *Tanea zelandica* Quoy & Gaimard (Naticidae) in New Caledonia. *J. Conchyl.* 97: 141 - 142.

1966. Marwick's Illustrations of New Zealand shells, with a Checklist of New Zealand Cenozoic Mollusca. *N.Z. Geol. Surv. Bull.* 173: 1 - 456; pls. 1 - 145.

FLEMING, John

1822. *The philosophy of zoology; or a general view of the structure, functions and classification of animals.* Edinburgh, 1: i - lii; 1 - 432; 2: 1 - 618; 5 pls.

FONTANNES, F.

1879-1882. *Les Invertébrés du Bassin Tertiaire du Sud-Est de la France. Les Mollusques Pliocènes de la vallée du Rhone et du Roussillon.* Paris, 1 (1-3): i - viii; 1 - 276; pls. 1 - 12 (Livr. 1: 1 - 76 = 1879; livr. 2 & 3: 77 - 276 = 1880).

GABB, William M.

1860. Descriptions of new species of American Tertiary and Cretaceous fossils. *J. Acad Nat. Sci. Philadelphia* 4: 375 - 406; pls. 67 - 69.

1861. Descriptions of some new species of Tertiary fossils from Chiriqui, Central America. *Proc. Acad. Nat. Sci. Philadelphia* 12: 567 - 568.

1873a. Descriptions of some new genera of Mollusca. *Proc. Acad. Nat. Sci. Philadelphia* 24: 270 - 274; pls. 9 - 11.

1873b. On the Topography and Geology of Santo Domingo. *Trans. Amer. Phil. Soc.* 15: 49 - 259.

GABRIEL, Charles J.

1962. Additions to the marine molluscan fauna of South Eastern Australia including descriptions of new genus *Pillarginella,* six new species and two subspecies. *Mem. Nat. Mus. Melbourne* No. 25: 177 - 210; plate.

GARDNER, Julia

1937. The molluscan fauna of the Alum Bluff Group of Florida. Part VI. Pteropoda, Opisthobranchia, and Ctenobranchia (in Part). *U.S. Geol. Surv. Prof. Pap.* 142F: 251 - 435; pls. 37 - 48.

1945. Mollusca of the Tertiary formation of Northeastern Mexico. *Geol. Soc. Amer. Mem.* 11: 1 - 332; pls. 1-28.

GARRARD, Thomas A.

1966. New species of Mollusca from Eastern Australia (Part 2), with notes on some known species. *J. Malac. Soc. Australia* No. 10: 3 - 12; pl. 1.

1969. Amendments to Iredale and McMichael's "Reference list of marine Mollusca of New South Wales", 1962. *J. Malac. Soc. Australia* No. 12: 3 - 17.

GARRETT, Andrew

1873. List of species of Mitridae collected at Rarotonga, Cook Islands, with Notes, also descriptions of new species. *Proc. Zool. Soc. Lond.* 1872: 839 - 843.

1880. Catalogue of the Polynesian Mitridae, with remarks on their geographical range, station, and descriptions of supposed new species. *J. Conch.* 3: 1 - 73.

GLIBERT, Maxime

1960. Les Volutacea fossiles du Cénozoique étranger des collections de l'Institut Royal des Sciences Naturelles de Belgique. *Inst. Roy. Sci. Nat. Belgique* ser. 2, 61: 1 - 109.

GMELIN, Johann Frederich

1791. *Systema naturae per regna tria naturae. Editio decima tertia, aucta, reformata.* Leipzig, 1 (6): 3021 - 3910.

GÖRGES, J.

1940. Die Oberoligocänfauna von Rumeln am Niederrhein. *Dechenia* 100A: 115 - 186.

GOULD, Augustus Addison

1850. Shells collected by the United States Exploring Expedition. *Proc. Boston Soc. Nat. Hist.* 3: 151 - 156; 169 - 172.

1852. *Mollusca and shells; in United States Exploring Expedition during the years* 1838-1842 *under the command of Charles Wilkes, U.S.N.* Boston, pp. i - xv; 1 - 510; Atlas pp. 1 - 16; pls. 1 - 52 (Atlas publ. 1861).

1856. Descriptions of new shells. *Proc. Boston Soc. Nat. Hist.* 6: 11 - 16.

1860. Descriptions of shells collected in the North Pacific Exploring Expedition. *Proc. Boston Soc. Nat. Hist.* 7: 323 - 340.

GRAHAM, Alastair

1966. The fore-gut of some marginellid and cancellarid Prosobranchs. *Stud. Trop. Oceanog. Univ. Miami* 4 (1): 134 - 151; textfigs.

GRANT-MACKIE, J. A.

1965. New Invertebrates from the Lower Miocene Pakaurangi Beds, Kaipara Harbour, with a redescription of the Gastropod *Clifdenia* Laws. *Trans. Roy. Soc. N.Z.* 3 (6): 85 - 94; pls. 1 - 2; textfigs.

GRANT, Ulysses S. and H. R. GALE

1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California and adjacent regions. *Mem. San Diego Soc. Nat. Hist.* 1: 1 - 1036; pls. 1 - 32.

GRATELOUP, M.

1833. Tableau (suite du) des coquilles fossiles qu'on rencontre dans les terrains tertiaires grossiers (faluns) du Bassin géologique de l'Adour (Landes). *Act. Soc. Linn. Bordeaux* 6 (37): 270 - 320.

1847. *Conchyliologie fossile des Terrains Tertiaires du Bassin de L'Adour (environs de Dax)*. Bordeaux, Atlas of plates & explanations.

GRAY, John Edward

1839. *Mollusca; in The Zoology of Captain Beechey's voyage compiled from the collections and notes made by Captain Beechey, the officers and naturalist of the expedition during a voyage to the Pacific and Behring's Straits performed in His Majesty's ship Blossom, under the command of Captain F. W. Beechey in the years* 1825, 26, 27, *and* 28. London, pp. i - xii; 1 - 180; pls. 1 - 44 + pls. 1 - 3 Geology.

1847. A list of the genera of Recent Molluscs, their synonyma and types. *Proc. Zool. Soc. Lond.* 1847, pt. 15: 129 - 219.

1857. *Guide to the systematic distribution of Mollusca in the British Museum. Part* I. London, pp. i - xii; 1 - 230.

GREGORIO, Antoine de

1890. Monographie de la faune éocenique de l'Alabama. *Ann. Géol. Paléont. Palermo* 7/8: 1 - 346; plates.

GRIFFITH, Edward and E. PIDGEON

1834. *The Animal Kingdom arranged in conformity with its organisation, by the Baron Cuvier. The Mollusca and Radiata.* London, 12: 1 - 601; pls. 1 - 41; 1 - 20.

GUALTIERI, Nicolai

1742. *Index testarum conchyliorum quae adservantur in Museo Nicolai Gualtieri.* Florence, 110 pls.; textfigs.

GUERIN-MENEVILLE, F. E. *et al.*

1831. *Magasin de Zoologie. Part* I, *Class* V; *Mollusques.* Paris, pp. 1 - 40; pls. 1 - 40.

HABE, Tadashige

1943. On the radulae of Japanese marine gastropods (I). *Venus: Jap. J. Malac.* 13 (1-4): 68 - 76; pls. 3 - 4.

1958. On the radulae of Japanese marine gastropods (4). *Venus: Jap. J. Malac.* 20 (1): 43 - 60; pls. 2 - 3.

1961. *Coloured Illustrations of the shells of Japan.* Osaka, 2: 1 - 183; pls. 1 - 66.

HABE, Tadashige and S. KOSUGE

1966a. *Shells of the world in colour. The tropical Pacific.* Osaka, 2: 1 - 193; pls. 1 - 68.

1966b. New genera and species of the tropical and subtropical Pacific Molluscs. *Venus: Jap. J. Malac.* 24 (4): 312 - 341; pl. 29.

1967. *The Standard Book of Japanese shell in color.* Osaka, pp. i - xviii; 1 - 223; pls. 1 - 64; textfigs.

HANLEY, Sylvanus

1856. *Index Testaceologicus, an illustrated catalogue of British and foreign shells.* London, pp. i - xx; 1 - 234; pls. 1 - 38; Suppl. pls. 1 - 8.

HARDY, G. H.

1916. List of the Tenison Woods types of recent Mollusca in the Tasmanian Museum. *Proc. Roy. Soc. Tasmania* pp. 61 - 73.

HARRIS, Gilbert D.

1895. New and otherwise interesting Tertiary Mollusca from Texas. *Proc. Acad. Nat. Sci. Philadelphia* 47: 45 - 88; pls. 1 - 9.

HARRIS, George F.

1897. *Catalogue of Tertiary Mollusca in the Department of Geology British Museum (Natural History). Part* I. *The Australian Tertiary Mollusca.* London, pp. i - xxvi; 1 - 407; pls. 1 - 8.

HARRIS, Gilbert D. and K. van W. PALMER

1947. The Mollusca of the Jackson Eocene of the Mississippi embayment (Sabine River to Alabama River). *Bull Amer. Paleont.* 30 (117): 209 - 563; pls. 26 - 65.

HATAI, Kotora and S. NISIYAMA

1952. Check List of Japanese Tertiary Marine Mollusca. *Sci. Rept. Tôhoku Univ.* ser. 2, Spec. Vol. 3: 1 - 464.

HEDLEY, Charles

1899. The Mollusca of Funafuti. Part I.—Gasteropoda. *Mem. Australian Mus.* 3 (7): 397 - 488; textfigs.

1901. Studies on Australian Mollusca. Part IV. *Proc. Linn. Soc. N.S.W.* 26 (1): 16 - 25; pl. 2.

1907. The Mollusca of Mast Head reef, Capricorn group, Queensland. Part II. *Proc. Linn. Soc. N.S.W.* 32 (3): 476 - 513; pls. 16 - 21.

1908. Studies on Australian Mollusca. Part X. *Proc. Linn. Soc. N.S.W.* 33 (3): 456 - 489; pls. 7 - 10bis.

1909. Mollusca from the Hope Islands, North Queensland. *Proc. Linn. Soc. N.S.W.* 34 (3): 420 - 466; plts. 36 - 44.

1911. Report on the Mollusca obtained by the F.I.S. *Endeavour,* chiefly off Cape Wiles, South Australia. *Zool. Res. Fish. Exp. "Endeavour"* pt. 1: 90 - 114; pls. 17 - 20.

1912. Descriptions of some new or noteworthy shells in the Australian Museum. *Rec. Australian Mus.* 8 (3): 131 - 160; pls. 40 - 45.

1913. Studies on Australian Mollusca. Part XI. *Proc. Linn. Soc. N.S.W.* 38 (2): 258 - 339; pls. 16 - 19.

1915. Studies on Australian Mollusca. Part XII. *Proc. Linn. Soc. N.S.W.* 39 (4): 695 - 755; pls. 77 - 85.

1916a. Studies on Australian Mollusca. Part XIII. *Proc. Linn. Soc. N.S.W.* 41 (4): 680 - 719; pls. 46 - 52.

1916b. A preliminary Index of the Mollusca of Western Australia. *J. Roy. Soc. W. Australia* 1: 3 - 77.

HELBLING, AUF HIRZENFELD, S. G.

1779. Beiträge zur Kenntnis neuer und seltener Conchylien. *Abh. Privatg. Böhmen* 4: 102 - 131; 4 pls.

HERRMANNSEN, August Nicolaus

1846-1849 *Indicis generum malacozoorum primordia.* Cassel, 1: i - xxvii; 1 - 637; 2: xxix - xlii; 1 - 717 (1: 1 - 232 = 1846; 233 - 637 = 1847; 2: 1 - 352 = 1848; 493 - 717 = 1849).

1852. *Indicis generum malacozoorum supplementa et corrigenda.* Cassel, pp. 1 - 140.

HERVIER, R. P.

1898-1899. Descriptions d'espèces nouvelles de Mollusques, provenant de l'Archipel de la Nouvelle-Calédonie. *J. Conchyl.* 45: 47 - 69; 225 - 248; pls. 9 - 10 (1898); 46: 209 - 213; pl. 10 (1899).

HINDS, Richard Brinsley

1844. Descriptions of new shells from the collection of Captain Sir Edward Belcher, R.N., C.B. *Ann. Mag. Nat. Hist.* 11: 255 - 257.

1844-1845. *The zoology of the voyage of H.M.S. Sulphur. Mollusca.* London, pt. 1: 1 - 24; pls. 1 - 7; pt. 2: 25 - 48; pls. 8 - 14 (1844); pt. 3: 49 - 72; pls. 15 - 21 (1845).

HODSON, Floyd and H. K. HODSON

1931. Some Venezuelan mollusks. Parts 1 & 2. *Bull. Amer. Paleont.* 16 (59): 1 - 94; pls. 1 - 24; 16 (60): 95 - 132; pls. 25 - 36.

HÖRNES, Moritz

1856. Die fossilen Mollusken des Tertiaer-Beckens von Wien. *Abh. k. k. geol. Reichs.* 3: 1 - 736; pls. 1 - 52.

HOERNES, Rudolf and M. AUINGER

1880. Die Gasteropoden der Meeres-Ablagerungen der ersten und zweiten Miocänen Mediterran-Stufe in der Österreichisch-Ungarischen Monarchie. *Abh. k. k. geol. Reichs.* 12 (2): 53 - 112; pls. 7 - 12.

HUTTON, Frederick Wollaston

1873a. *Catalogue of the Tertiary Mollusca and Echinodermata of New Zealand.* Wellington, pp. i - xvi; 1 - 48.

1873b. *Catalogue of the Marine Mollusca of New Zealand with diagnoses of the species.* Wellington, pp. i - xx; 1 - 116.

1885. Descriptions of new Tertiary shells. Part I. & II. *Trans. N.Z. Inst.* 17: 313 - 324; pl. 18; 17: 325 - 332.

1905. Three new Tertiary shells. *Trans N.Z. Inst.* 37: 472 - 473; pl. 44.

ICKE, H. and K. MARTIN

1907. Over Tertiaire en Kwartaire vormingen van het Eiland Nias. *Samml. Geol. Reichsm. Leiden* ser. 1, 8: 204 - 252; 5 pls.

IHERING, Hermann von

1897. Os Molluscos dos terrenos terciarios da Patagonia. *Rev. Mus. Paulista* 2: 217 - 382; pls. 3 - 9.

1907. Les Mollusques fossiles du Tertiaire et du Crétacé Superieure de L'Argentine. *Ann. Mus. Nac. Buenos Aires* ser. 3, 7: 1 - 611; pls. 1 - 18; textfigs.

IREDALE, Tom

1911. On the value of the gastropod apex in classification. *Proc. Malac. Soc. Lond.* 9: 319 - 323.

1924. Results from Roy Bell's Molluscan collections. *Proc. Linn. Soc. N.S.W.* 49 (3): 179 - 278; pls. 33 - 36.

1929a. Queensland Molluscan Notes, No. 1. *Mem. Queensland Mus.* 9 (3): 261 - 297; pls. 30 - 31.

1929b. Strange Molluscs in Sydney Harbour. *Australian Zool.* 5 (4): 337 - 352; pls. 37 - 38.

1936. Australian Molluscan Notes, No. 2. *Rec. Australian Mus.* 19 (5): 267 - 340; pls. 20 - 24.

ISSEL, Arturo

1869. *Malacologia del Mar Rosso ricerche zoologiche e paleontologiche.* Pisa, pp. i - xi; 1 - 387; pls. 1 - 5.

JICKELI, Carl F.

1874. Studien über die Conchylien des Rothen Meeres. *Jahrb. Deut. Malak. Gesell.* 1: 17 - 54.

JOHNSON, Richard I.

1964. The Recent Mollusca of Augustus Addison Gould. *Bull. U.S. Nat. Mus.* 239: 1 - 182; pls. 1 - 45.

JOHNSTON, R. M.

1880. Third contribution to the natural history of the Tertiary marine beds of Table Cape, with descriptions of thirty new species of Mollusca. *Proc. Roy. Soc. Tasmania* pp. 29 - 41.

JOUSSEAUME, F. P.

1898. Description d'un Mollusque nouveau. *Le Naturaliste* No. 268: 106 - 107; textfigs.

KAY, E. Alison

1965. Marine molluscs in the Cuming collection, British Museum (Natural History) described by William Harper Pease. *Bull. Brit. Mus. (Nat. Hist.) Zool. Suppl.* 1: 1 - 96; pls. 1 - 14.

KEEN, A. Myra

1958. *Sea shells of tropical West America.* Stanford, pp. i - viii; 1 - 624; pls. 1 - 10; textfigs.

KESTEVEN, H. Leighton

1912. The constitution of the Gastropod protoconch: its value as a taxonomic feature and the significance of some of its forms. *Proc. Linn. Soc. N.S.W.* 37 (1): 49 - 82; pl. 1.

KIENER, Louis Charles

1838-1839. *Spécies général et iconographie des coquilles vivantes. Famille des Columellaires. Genre Mitre.* Paris, 3: 1 - 120; pls. 1 - 34 (plates 1838; text 1839).

KING, Phillip P. and W. J. BRODERIP

1832. Description of the Cirrhipeda, Conchifera and Mollusca, in a collection formed by the Officers of H.M.S. *Adventure* and *Beagle* employed between the years 1826 and 1830 in surveying the Southern coasts of South America, including the Straits of Magalhaens and the coast of Tierra del Fuego. *Zool. J.* pp. 332 - 349.

KIRA, Tetsuaki

1959a. Descriptions on *Siphonalia trochulus tokaiensis* n.subsp. and *Mitra hayashii* n.sp. *Venus: Jap. J. Malac.* 20 (4): 339 - 344; textfigs.

1959b. *Coloured Illustrations of the shells of Japan.*. Osaka, rev. ed., 1: 1 - 239; 71 pls.

KNUDSEN, Jorgen

1956. *Marine Prosobranchs of tropical West Africa (Stenoglossa). Atlantide Report No.* 4. *Scientific Results of the Danish Expedition to the coasts of tropical West Africa* 1945-46. Copenhagen, pp. 7 - 110; pls. 1-4.

KOBELT, W.

1876-1878. *Illustriertes Conchylienbuch.* Nürnberg, 1: 1 - 143; pls. 1 - 50.

KOENEN, A. von

1890. Das Norddeutsche Unter-Oligocän und seine Mollusken-Fauna. Lieferung II: Conidae-Volutidae-Cypraeidae. *Abh. geol. königl. Preuss. Land.* 10 (2): 281 - 574; pls. 24 - 39.

KOPERBERG, E. J.

1931. Ze Nederlandsche Timor-Expeditie 1916. Jungtertiäre und Quartäre Mollusken von Timor. *Jaarb. Mijn. Nederl. Indie* pp. 1 - 165; pls. 1 - 3.

KURODA, Tokubei and K. SAKURAI

1958. New Japanese shells. *Venus: Jap. J. Malac.* 20 (2): pls. 20 - 21.

KURODA, Tokubei

1959. Descriptions of new species of marine shells from Japan. *Venus: Jap. J. Malac.* 20 (4): 317 - 335; textfigs.

KUSTER, H. C.

1839-1841. *Systematisches Conchylien-Cabinet von Martini und Chemnitz. Fünften Bandes zweite Abtheilung. Die Familie der Walzenschnecken (Volutacea, Menke).* Nürnberg, 5 (2): i - x; 1 - 234; pls. 1 - 49. Collation for Mitridae: pp. 33 - 104; pls. 7 - 11, 11 - 15, 26 - 27 (1839); pp. 105 - 150; pls, 12, 16 - 17, 17a - 17b, 34 (1840); pls. 17c - 17e (1841).

LADD, Harry S.

1934. Geology of Viti Levu, Fiji. *Bern. P. Bish. Mus. Bull.* 119: 1 - 263; pls. 1 - 44; textfigs.

1960. Origin of the Pacific Island fauna. *Amer. J. Sci.* Bradley Vol. 258A: 137 - 150; textfigs.

LADD, Harry S. and J. E. HOFFMEISTER

1945. Geology of Lau, Fiji. *Bern. P. Bish. Mus. Bull.* 181: 1 - 396; pls. 1 - 62.

LAMARCK, J. B. P. A. de Monet de

1798. *Tableau encyclopédique et méthodique des trois regnes de la nature.* Paris, pls. 287 - 390.

1801. *Systeme des animaux sans vertèbres, ou tableau général des classes, des ordres et des genres de ces animaux.* Paris, pp. i - viii; 1 - 432.

1803. Suite des mémoires sur les fossiles des environs de Paris. Genre XII. *Mitra. Ann. Mus. d'Hist. Nat. Paris* 2 (1): 57 - 64.

1811. Sur la détermination des espèces parmi les animaux sans vertèbres, et particulièrement parmi les mollusques testacés. *Ann. Mus. d'Hist. Nat. Paris* 17: 195 - 222.

1816. *Tableau Encyclopédique et méthodique des trois règnes de la nature.* Paris, pp. 1 - 16; pls. 391 - 488.

1822. *Histoire naturelle des animaux sans vertèbres; Mollusques.* Paris, 7: 1 - 711.

LAMY, Edouard

1926. Sur diverses coquilles de la mer Rouge figurées en 1830 par Léon de Laborde. *Bull. Mus. d'Hist. Nat. Paris* 32 (2): 378 - 383.

LASERON, Charles F.

1951. Notes on the New South Wales Mitras with special reference to their protoconchs. *Rec. Australian Mus.* 22 (4): 335 - 343; textfigs.

LAWS, Charles R.

1932. New Tertiary Mollusca from New Zealand, No. 2. *Trans. N.Z. Inst.* 62 (3/4): 183 - 202; pls. 26 - 32.

1936. The Waitotaran faunule at Kaawa Creek, Part 2. *Trans. N.Z. Inst.* 66 (2): 99 - 124; pls. 15 - 17.

LAWS, Helene M.

1965. Chromosomes of snails introduced into South Australia and the Northern Territory. *Rec. Sth. Australian Mus.* 15 (1): 79 - 87.

LEA, Isaac

1833. *Contributions to Geology.* Philadelphia, pp. i - vi; 1 - 227; pls. 1 - 6.

LEMCHE, Henning

1948. Northern and Arctic Tectibranch gastropods. I. The larval shells. II. A revision of the Cephalopod species. *Kong. Dans. Vid. Sel. Biol. Skrift.* 5 (3): 1 - 136; textfigs.

LESSON, René Primèvere

1831. *Voyage Autour du Monde, exécuté par ordre du Roi, sur la corvette de La Majesté, La Coquille, pendant les années* 1822, 1823, 1824 *et* 1825. *Zoologie.* Paris 2 (1): 239 - 471; pls.

1832-1835. *Illustrations de Zoologie, ou recueil de figures de Animaux.* Paris, 60 pls. (livr. 1 - 5 = 1832; livr. 6 - 11 = 1833; livr. 12 - 14 = 1834; livr. 15 - 20 = 1835).

1842a. Mollusques recueillis dans la mer du Sud par M. Adolphe Lesson (Genres *Mitra* et *Pleurotoma*). *Rev. Zool. Soc. Cuvier.* 5: 141 - 144.

1842b. Mollusques. *L'Echo Mond. Savant* 9 (3): 65 - 66.

LIENARD, E.

1869. Note sur le *Mitra desetangsii,* Kiéner. *J. Conchyl.* 17: 226 - 227.

LIGHTFOOT, John

1786. *A catalogue of the Portland Museum, lately the property of the Duchess of Portland.* London, pp. i - viii; 1 - 194.

LINK, Heinrich Friedrich

1807. *Beschreibung der Naturalien-Sammlung der Universität zu Rostock. Dritte Abtheilung.* Rostock, pp. 101-160.

LINNAEUS, Carolus

1758. *Systema naturae per regna tria naturae. Editio decima, reformata.* Stockholm, pp. 1 - 824.

1767. *Systema naturae per regna tria naturae. Editio duodecima, reformata.* Stockholm, 1 (2): 533 - 1327.

1771. *Mantissa Plantarum altera. Regni Animalis Appendix.* Stockholm, pp. 143 - 510.

LISTER, Martin

1685-1692. *Historiae sive synopsis methodicae conchyliorum.* London, 2 Vols. 6 parts; 1057 pls.

LOCARD, Arnould

1890. Notices Conchyliologiques; les Mitres des côtes de France. *L'Échange Rev. Linn.* 6 (62): 109 - 110.

1897. *Expéditions scientifiques du Travailleur et du Talisman pendant les années* 1880, 1881, 1882, 1883. *Mollusques Testacés.* Paris, 1: 1 - 516; pls. 1 - 22.

Ludbrook, Nellie Hooper

1941. Gastropoda from the Abbatoirs Bore, Adelaide, South Australia, together with a list of some miscellaneous fossils from the bore. *Trans. Roy. Soc. Sth. Australia* 65 (1): 79 - 102; pls. 4 - 5.

1958. The Molluscan fauna of the Pliocene Strata underlying the Adelaide Plains, Part V—Gastropoda (Eratoidae to Scaphandridae). *Trans. Roy. Soc. Sth. Australia* 81: 43 - 111; pls. 1 - 6.

1967. Tertiary Molluscan types from Table Cape in the Tasmanian Museum, Hobart. *Proc. Roy. Soc. Tasmania* 101: 65 - 69; pls. 1 - 4.

MacNeil, Francis Stearns

1961. Tertiary and Quaternary Gastropoda of Okinawa. *U.S. Geol. Surv. Prof. Pap.* No. 339: 1 - 148; pls. 1 - 21; textfigs.

Macpherson, J. Hope and C. J. Gabriel

1962. *Marine Mollusca of Victoria.* Melbourne, pp. i - xv; 1 - 475; textfigs.

Makiyama, Jirô

1927. Molluscan Fauna of the lower part of the Kakegawa series in the Province of Totômi, Japan. *Mem. Coll. Sci. Kyoto Imp. Univ.* ser. B, 3 (1): 1 - 147; pls. 1 - 6.

1931. Stratigraphy of the Kakegawa Pliocene in Totômi. *Mem. Coll. Sci. Kyoto Imp. Univ.* ser. B, 7 (1): 1 - 53; pls. 1 - 3.

Mansfield, Wendell C.

1925. Miocene gastropods and scaphopods from Trinidad. *Proc. U.S. Nat. Mus.* 66 (22): 1 - 65; pls. 1 - 10.

1930. Miocene Gastropods and Scaphopods of the Choctawhatchee formation of Florida. *Florida State Geol. Surv. Bull.* No. 3: 1 - 185; pls. 1 - 21.

Marcus, Ernst and E. Marcus

1959. Studies on "Olividae". *Bol. Fac. Fil. Univ. Sao Paulo Zool.* 22: 99 - 188.

Marryat, Frederic

1817. Descriptions of two new shells. *Trans. Linn. Soc. Lond.* 12 (2): 338 - 339; pl. 10.

Marshall, Patrick

1918. The Tertiary Molluscan fauna of Pakaurangi Point, Kaipara Harbour. *Trans. N.Z. Inst.* 50: 263 - 278; pls. 12 - 22.

Marshall, Patrick and R. Murdoch

1923. Some Tertiary Mollusca with descriptions of new species. *Trans. N.Z. Inst.* 54: 121 - 128; pls. 12 - 15.

Martens, Edouard von

1880. *Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen. Mollusken.* Berlin, pp. 181 - 336; pls. 19 - 22.

1887. List of the shells of Mergui and its Archipelago, collected for the Trustees of the Indian Museum, Calcutta, by Dr. John Anderson, F.R.S., Superintendent of the Museum. *J. Linn. Soc. Lond.* 21 (130): 155 - 219; pls. 14 - 16.

1904. *Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898-1899. Die beschalten Gastropoden.* Jena, 7: 1 - 174; pls. 1 - 9.

Martin, Karl Johann Ludwig

1880. *Die Tertiärschichten auf Java, nach den Entdeckungen von Fr. Junghuhn.* Leiden, pp. 1 - 164; 1 - 51; 1 - 6; pls. 1 - 28.

1916. Die altmiocäne Fauna des West-Prosogebirges auf Java. A. Gastropoda. *Samml. geol. Reichsm. Leiden N.F.* 2 (6): 223 - 308; pls. 1 - 5.

1931. Mollusken aus dem Obereocän von Nanggulan. *Wet. Meded. Mijnb. Nederl.-Indie* No. 18: 1 - 56; pls. 1-7.

Martyn, Thomas

1784-1786. *The Universal Conchologist.* London, Vols. 1 & 2: pls. 1 - 80 (1784); Vols. 3 & 4: pls. 81 - 160 (1786).

Marwick, John

1926a. Molluscan fauna of the Waiarekan stage of the Oamaru series. *Trans. N.Z. Inst.* 56: 307 - 316; pl. 72.

1926b. New Tertiary Mollusca from North Taranaki. *Trans. N.Z. Inst.* 56: 317 - 331; pls. 73 - 75.

1928. The Tertiary Mollusca of the Chatham Islands including a generic revision of the New Zealand Pectinidae. *Trans. N.Z. Inst.* 58 (3): 432 - 506; figs.

1929. Tertiary Molluscan fauna of Chatton, Southland. *Trans. N.Z. Inst.* 59 (4): 903 - 934; figs.

1931. The Tertiary Mollusca of the Gisborne District. *N.Z. Geol. Surv. Paleont. Bull.* 13: 1 - 177; pls. 1 - 18.

1942. Some Eocene Mollusca from New Zealand. *Trans. Roy. Soc. N.Z.* 72 (3): 268 - 279; pls. 23 - 25.

1965. Upper Cenozoic Mollusca of Wairoa District, Hawke's Bay. *N.Z. Geol. Surv. Paleont. Bull.* 39: 1 - 59; pls. 1 - 11.

Matheron, Philippe

1843. *Catalogue méthodique et descriptif des corps organisés fossiles du Département des Bouches-du-Rhone et lieux circonvoisins.* Marseille, pp. 1 - 269; pls. 1 - 41.

MAURY, Carlotta J.

1910. New Oligocene shells from Florida. *Bull. Amer. Paleont.* 4: 119 - 164; pls. 18 - 26.

1912. A contribution to the paleontology of Trinidad. *J. Acad. Nat. Sci. Philadelphia* ser. 2, 15: 25 - 112; pls. 5 - 13.

1925. A further contribution to the paleontology of Trinidad (Miocene horizons). *Bull. Amer. Paleont.* 10: 155-402; pls. 12 - 54.

MAY, W. L.

1903. On Tenison-Woods types in the Tasmanian Museum, Hobart. *Proc. Roy. Soc. Tasmania* pp. 106 - 114; textfigs.

1915. Additions to the Tasmanian marine mollusca, with descriptions of new species. *Proc. Roy. Soc. Tasmania* pp. 75 - 99; pls. 1 - 8.

1923. *An Illustrated Index of Tasmanian shells.* Govt. Printer, Hobart. pp. 1 - 100; pls. 1 - 47.

MAYER-EYMAR, C.

1891a. Diagnoses specium novarum. Mitridae. *Vierteljahr. naturf. Gesell. Zürich* 35: 298 - 301.

1891b. Description de coquilles fossiles des terrains tertiaires supérieurs (suite). *J. Conchyl.* 39: 317 - 344; pls. 8 - 10.

MCGINTY, Thomas L.

1955. New marine molluscs from Florida. *Proc. Acad. Nat. Sci. Philadelphia* 107: 75 - 85; pls. 1 - 2.

MCLEAN, James H.

1967. Note on the radula of *Mitromica* Berry, 1958. *The Veliger* 10 (1): 58; textfig.

MEEK, Fielding Bradford

1873. Paleontological report. *U.S. Geol. Surv. Territ.* 6th *Ann. Rept.* Pt. 1: 429 - 518.

1876. A report on the invertebrate Cretaceous and Tertiary fossils of the Upper Missouri country. *Rept. U.S. Geol. Surv. Territ.* 9: i - lxiv; 1 - 629; pls. 1 - 45.

MELVILL, James Cosmo

1888a. Descriptions of fifteen new species of *Mitra*. *J. Conch.* 5: 281 - 288; pl. 2.

1888b. Notes on *Mitra(Costellaria)rugosa* (Swainson). *J. Conch.* 5: 332 - 335.

1893. Description of a new species of *Mitra*. *The Conchologist* 2 (6): 140; pl. 1.

1895. Descriptions of new species of *Pleurotoma, Mitra* and *Latirus*. *Proc. Malac. Soc. Lond.* 1 (5): 221 - 223; pl. 14.

1897. Descriptions of thirty-four species of marine Mollusca from the Arabian Sea, Persian Gulf, and Gulf of Oman (mostly collected by F. W. Townsend, Esq.). *Mem. Proc. Manchester Lit. Phil. Soc.* 41 (3): 1 - 25; pls. 6 - 7.

1899a. Description of a new species of *Mitra* (*M.baldwinii*) from the Hawaiian Islands. *J. Malac.* 7 (3): 67 - 68; textfigs.

1899b. Notes on the Mollusca of the Arabian Sea, Persian Gulf, and Gulf of Oman, mostly dredged by Mr. F. W. Townsend, with descriptions of twenty-seven species. *Ann. Mag. Nat. Hist.* (7) 4: 81 - 101; pls. 1-2.

1899c. Notes on a third collection of marine shells from the Andaman Islands, with descriptions of three new species of *Mitra*. *Proc. Malac. Soc. Lond.* 3 (4): 220 - 229; textfigs.

1904a. Descriptions of twenty-eight species of Gastropoda from the Persian Gulf, Gulf of Oman, and Arabian Sea, dredged by Mr. F. W. Townsend, of the Indo-European Telegraph service, 1900-1904. *Proc. Malac. Soc. Lond.* 6 (3): 158 - 169; pl. 10.

1904b. Note on *Mitra stephanucha*, Melv., with description of a proposed new variety. *J. Malac.* 11 (4); 86; pl. 8.

1910. Descriptions of twenty-nine species of marine Mollusca from the Persian Gulf, Gulf of Oman, and North Arabian Sea, mostly collected by Mr. F. W. Townsend, of the Indo-European Telegraph service. *Ann. Mag. Nat. Hist.* (8) 6: 1 - 17; pls. 1 - 2.

1918. Descriptions of thirty-four species of marine Mollusca from the Persian Gulf, Gulf of Oman, and Arabian Sea, collected by Mr. F. W. Townsend. *Ann. Mag. Nat. Hist.* (9) 1: 137 - 158; pls. 4 - 5.

1925. Descriptions of nine new species of Mitridae. *Proc. Malac. Soc. Lond.* 16 (5): 215 - 219; pl. 10.

1927. Descriptions of eight new species of the family Turridae and of a new species of *Mitra*. *Proc. Malac. Soc. Lond.* 17 (4): 149 - 155; pl. 12.

1928. The marine mollusca of the Persian Gulf, Gulf of Oman, and the North Arabian Sea, as evidenced mainly through the collections of Captain F. W. Townsend, 1893-1914. Addenda, Corrigenda and Emendanda. *Proc. Malac. Soc. Lond.* 18: 93 - 117.

MELVILL, James Cosmo and R. STANDEN

1895-1897. Notes on a collection of shells from Lifu and Uvea, Loyalty Islands, formed by the Rev. James and Mrs. Hadfield, with list of species. *J. Conch.* 8: 84 - 129; pls. 2 - 3 (1895); 8: 130 - 132; 273 - 315; pls. 9 - 11 (1896); 8: 379 - 381; 396 - 421 (1897).

1901. The Mollusca of the Persian Gulf, Gulf of Oman, and Arabian Sea, as evidenced mainly through the collections of Mr. F. W. Townsend, 1893-1900; with descriptions of new species. *Proc. Zool. Soc. Lond.* 1901, 2: 327 - 460; pls. 21 - 24.

1903. Descriptions of sixty-eight new Gastropoda from the Persian Gulf, Gulf of Oman, and North Arabian Sea, dredged by Mr. F. W. Townsend, of the Indo-European Telegraph service, 1901-1903. *Ann. Mag. Nat. Hist.* (7) 12: 289 - 324; pls. 20 - 23.

1912. The marine mollusca of the Scottish National Antarctic Expedition. Part II. *Trans Roy. Soc. Edinburgh* 48: 333 - 366; 1 pl.

MELVILL, James Cosmo and E. R. SYKES

1897. Notes on a collection of marine shells from the Andaman Islands, with descriptions of new species. *Proc. Malac. Soc. Lond.* 2 (4): 164 - 172; pl. 13.

MENKE, Karl Theodor

1829. *Verzeichniss der ansehnlichen Conchylien-Sammlung des Freiherrn von der Malsburg.* Pyrmont, pp. i - vi; 1 - 23.

MENZEL, R. W.

1968. Chromosome number in nine families of marine pelecypod mollusks. *The Nautilus* 82 (2): 45 - 50; pls. 53 - 58.

MEYER, Otto

1886. Contributions to the Eocene paleontology of Alabama and Mississippi. Pt. 2. *Geol. Surv. Alabama Bull.* No. 1: 63 - 85; pls. 1 - 2.

MIGHELS, Jesse Wedgewood

1845. Descriptions of shells from the Sandwich Islands and other localities. *Proc. Boston Soc. Nat. Hist.* 2: 18 - 25.

MONTEROSATO, Tommaso di

1917. Molluschi viventi e Quaternari raccolti longole coste della Tripolitania dall' ing. Camillo Crema. *Boll. Soc. Zool. Ital.* 4: 1 - 28; 1 pl.; textfigs (not published in this Journal, pre-printed privately).

MONTFORT, Pierre Denys de

1810. *Conchyliologie systématique, et classification méthodique des coquilles. Coquilles univalves.* Paris, 2: 1 - 676; 1 - 16; textfigs.

MONTROUZIER, R. P.

1858. Descriptions d'espèces nouvelles de l'Archipel Calédonien. *J. Conchyl.* 7: 373 - 375.

1860. Descriptions d'espèces nouvelles de l'Archipel Calédonien. *J. Conchyl.* 8: 111 - 122; pl. 2.

MONTROUZIER, R. P. in M. SOUVERBIE

1861. Description d'espèces nouvelles de l'Archipel calédonien. *J. Conchyl.* 9: 271 - 284; pl. 11.

MOORE, E. J.

1962. Conrad's Cenozoic fossil marine mollusk type specimens at the Academy of Natural Sciences of Philadelphia. *Proc. Acad. Nat. Sci. Philadelphia* 114: 23 - 120; pls. 1 - 2.

MOORE, Raymond C. *et al.*

1960. *Treatise on Invertebrate Paleontology. Part* I. *Mollusca* 1. Geol. Soc. America, University of Kansas Press, pp. i - xxiii; 1 - 351; textfigs.

MÖRCH, O. A. L.

1852. *Catalogus Conchyliorum quae reliquit D'Alphonso D'Aguirra & Gadea Comes de Yoldi.* Hafniae, fasc. 1: 1 - 170.

MURDOCH, R.

1905. Additions to the Marine Mollusca of New Zealand. *Trans. N.Z. Inst.* 37: 217 - 232; pls. 7 - 8.

MURDOCH, R. and H. SUTER

1906. Results of dredging on the Continental shelf of New Zealand. *Trans. N.Z. Inst.* 38: 278 - 305; pls. 21-27.

NEVILL, G. and H. NEVILL

1874. Description of new Marine Mollusca from the Indian Ocean. *J. Asiat. Soc. Bengal* 43 (2): 21 - 30; pl. 1.

1875. Description of new Marine Mollusca from the Indian Ocean. *J. Asiat. Soc. Bengal* 44 (2): 83 - 104; pls. 7 - 8.

NEWCOMB, Wesley

1870. Descriptions of new species of marine mollusca. *Amer. J. Conch.* 5 (3): 163 - 164; pl. 17.

NEWTON, Richard Bullen

1891. *Systematic List of the Frederick E. Edwards collection of British Oligocene and Eocene Mollusca in the British Museum (Natural History).* London, pp. i - xxviii; 1 - 365.

NOMURA, Sitihei

1935. Catalogue of the Tertiary and Quaternary Mollusca from the Island of Taiwan (Formosa) in t he Institute of Geology and Palaeontology, Tohoku Imperial University, Sendai, Japan. *Sci. Rept. Tohoku Imp. Univ.* 18 (2): 53 - 228; pls. 6 - 10.

NOWELL-USTICKE, G. W.

1959. *A check list of the Marine shells of St. Croix, U.S. Virgin Islands with random annotations.* Burlington, pp. i - iii; 1 - 90; pls. 1 - 4.

ODHNER, Nils J.

1919. Contribution á la faune malacologique de Madagascar. *Ark. Zool.* 12 (6): 1 - 52; pls. 1 - 4.

1924. Papers from Dr. Th. Mortensen's Pacific Expedition 1914-1916. *Vid. Medd. Dansk nat. For.* 77: 1 - 90; pls. 1 - 2; textfigs.

1931. Beiträge zur Malakozoologie der Kanarischen Inseln. Lamellibranchien, Cephalopoden, Gastropoden. *Ark. Zool.* 23A (14): 1 - 116; pls. 1 - 2; textfigs.

OINOMIKADO, Tuneteru

1939. Miocene Mollusca from the neighbourhood of Cucurrupi, Department of Chocó, Colombia. *J. Geol. Soc. Japan* 46: 103 - 116; pl. 29.

OLDROYD, Ida Shepard

1927. *The marine shells of the west coast of North America.* Stanford Univ. Press, 2 (1): 1 - 297; pls. 1 - 29.

OLSSON, Axel A.

1916. New Miocene fossils. *Bull. Amer. Paleont.* 27: 1 - 32; pls. 1 - 3 (14 - 16).

1922. The Miocene of Northern Costa Rica. Part I. *Bull. Amer. Paleont.* 9 (39): 9 - 167; pls. 1 - 15.

1930. Contributions to the Tertiary paleontology of northern Peru; pt. 3. Eocene Mollusca. *Bull. Amer. Paleont.* 17 (62): 1 - 96; pls. 1 - 12.

1942. Tertiary and Quaternary fossils from the Burica Peninsula of Panama and Costa Rica. *Bull. Amer. Paleont.* 27 (106): 1 - 80; pls. 1 - 12.

1964. Neogene mollusks from north-western Ecuador. *Paleont. Res. Instit. Ithaca* pp. 1 - 256; pls. 1 - 38.

OLSSON, Axel A. and A. HARBISON

1953. Pliocene Mollusca of Southern Florida with special reference to those from North Saint Petersburg. Part I. *Acad. Nat. Sci. Philadelphia Mon.* No. 8: 1 - 361; pls. 1 - 65.

OOSTINGH, C. H.

1931. Beitrag zur Kenntnis der Molluskenfauna von Süd-Sumatra. *Arch. Mollusk.* 63 (4/6): 166 - 257; pls. 18 - 20.

1935. Die Mollusken des Pliozäns von Boemiajoe (Java). *Weten. Meded. Mijnb. Nederl.-Indie* No. 26: 1 - 247; pls. 1 - 17.

1939. Die Mollusken des Pliocäns von Süd-Bantam in Java. 2. Abschnitt (Gastropoda II). *Ing. Nederl. Indie Mijnb. Geol.* 6 (1 & 4): 119 - 187; pls. 8 - 16.

OPPENHEIM, Paul

1906. Über einige Fossilien der Côte des Basques bei Biarritz. *Zeit. Deut. Geol. Gesell.* 58: 77 - 91; pl. 9; textfigs.

ORBIGNY, Alcide Dessalines d'

1842-1843. *Paléontologie Francaise. Description zoologique et géologique de tous les Animaux Mollusques et Rayonnés fossiles de France. Gastropoda.* Paris, 2: 1 - 456; pls. 149 - 236.

1850-1852. *Prodrome de Paléontologie Stratigraphique Universelle des Animaux Mollusques & Rayonnés.* Paris, 1: i - lx; 1 - 394; 2: 1 - 427 (1850); 3: 1 - 196; Ind. pp. 1 - 189 (1852).

ORBIGNY, Alcide D. in P. B. WEBB and S. BERTHELOT

1839. *Mollusques, Echinoderms, Foraminifères et Polypiers, recueillis aux Îles Canaries; in Histoire naturelle des Iles Canaries. Zoologie.* Paris, 2 (2): 1 - 152; pls. 1 - 15.

ORR-MAES, Virginia

1967. The littoral Marine Mollusks of Cocos-Keeling Islands (Indian Ocean). *Proc. Acad. Nat. Sci. Philadelphia* 119 (4): 93 - 217; pls. 1 - 26; textfigs.

OSTERGAARD, Jens Mathias

1935. Recent and fossil Marine Mollusca of Tongatabu. *Bern. P. Bish. Mus. Bull.* 131: 1 - 59; pl. 1; textfigs.

1950. Spawning and Development of some Hawaiian Marine Gastropods. *Pacif. Sci.* 4 (2): 75 - 115; textfigs.

PACE, S.

1902. Contributions to the study of the Columbellidae: No. 1. *Proc. Malac. Soc. Lond.* 5 (1/2): 36 - 154.

PALLARY, Paul

1900. Coquilles marines du littoral du Départment d'Oran. *J. Conchyl.* 48: 211 - 422; pls. 6 - 8.

PALMER, K. van Winkle

1937. The Claibornian Scaphopoda, Gastropoda and Dibranchiate Cephalopoda of the Southern United States. *Bull. Amer. Paleont.* 7 (32): 1 - 730; pls. 1 - 90.

1967. A comparison of certain Eocene Molluscs of the Americas with those of the Western Tethys. *Syst. Assoc. Public.* No. 7: 183 - 193.

PALMER, K. van W. and D. C. BRANN

1966. Catalogue of the Paleocene and Eocene mollusca of the southern and eastern United States. Part I. Pelecypoda, Amphineura, Pteropoda, Scaphopoda and Cephalopoda. Part II. Gastropoda. *Bull. Amer. Paleont.* 48 (218): 1 - 1057; 5 pls.

PANNEKOEK, Anna

1936. *Beiträge zur Kenntnis der altmiocänen Molluskenfauna von Rembang (Java).* Amsterdam, pp. 1 - 88; pls. 1 - 4.

PEASE, William Harper

1860. Descriptions of new species of Mollusca from the Sandwich Islands. *Proc. Zool. Soc. Lond.* 1860, pt. 28: 141 - 148.

1865. Descriptions of new genera and species of Marine shells from the Islands of the Central Pacific. *Proc. Zool. Soc. Lond.* 1865: 512 - 516.

1868a. Descriptions of Marine Gasteropodae inhabiting Polynesia. *Amer. J. Conch.* 3 (3): 211 - 222; pl. 15.

1868b. Describtions of sixty-five new species of Marine Gasteropodae, inhabiting Polynesia. *Amer. J. Conch.* 3 (4): 271 - 297; pls. 23 - 24.

1869a. Descriptions of new species of Marine Gastropodae inhabiting Polynesia. *Amer. J. Conch.* 5 (2); 64 - 79; pl. 8.

1869b. Corrections and additions to "Synonomy of Marine Gasteropodae inhabiting Polynesia". *Amer. J. Conch.* 5 (2): 85 - 87.

PEILE, A. J.

1922a. Some notes on radulae. *Proc. Malac. Soc. Lond.* 15 (1): 13 - 18; textfigs.

1922b. The radula in some Mitridae. *Proc. Malac. Soc. Lond.* 15 (2/3): 93 - 94; textfigs.

1936. Radula notes. *Proc. Malac. Soc. Lond.* 22 (3): 139 - 144; textfigs.

1937. Radula notes.—II. *Proc. Malac. Soc. Lond.* 22 (4): 181 - 186; textfigs.

1938. Radula notes, V. *Proc. Malac. Soc. Lond.* 23 (2): 97 - 100; textfigs.

PERRY, George

1811. *Conchology, or the natural history of shells.* London, pp. 1 - 4; pls. 1 - 61.

PETIT DE LA SAUSSAYE, M. S.

1851. Description de coquilles nouvelles. *J. Conchyl.* 2: 259 - 269; pls. 7 - 8.

1852. Description de coquilles nouvelles. *J. Conchyl.* 3: 51 - 59; pl. 2.

PEYROT, A.

1928. Conchologie Néogénique de L'Aquitaine. Vol. 5. (Gastropoda). *Act. Soc. Linn. Bordeaux* 78: 207 - 479; pls. 1 - 14.

1938. Les mollusques testacés Univalves des dépots Helvétiens du Bassin Ligérien. *Act. Soc. Linn. Bordeaux* Suppl. 89: 1 - 361; pls. 1 - 5.

PFEIFFER, Louis

1840. *Kritisches Register zu Martini und Chemnitz, Systematisches Conchylien Cabinet.* Kassel, pp. i - viii; 1-112.

PHILIPPI, Rudolphus Amandus

1836. *Enumeratio Molluscorum Siciliae, cum viventium tum in tellure Tertiaria fossilium quae in itinere suo observavit.* Berlin, 1: i - xiv; 1 - 267; pls. 1 - 12.

1847. Beschreibung zweier neuer Conchyliengeschlechter, *Dibaphus* und *Amphichaena,* nebst einigen Bemerkungen über *Cyamium, Ervilia* und *Entodesma. Arch. Naturg.* 13 (1): 61 - 66; pl. 3.

1850. Bemerkungen über einige Arten von *Mitra. Zeit. Malakozool.* 7 (1): 22 - 30.

1851. Centuria quinta Testaceorum novorum. *Zeit. Malakozool.* 8 (6): 81 - 96.

1887. *Die Tertiären und Quartären Versteinerungen Chiles.* Leipzig, pp. 1 - 266; pls. 1 - 58.

PICTET, F. J. and G. CAMPICHE

1861-1864. *Matériaux pour la Paléontologie Suisse. Description des Fossiles du Terrain Crétacé des environs de Sainte-Croix.* Geneva, pp. 1 - 752; pls. 44 - 98 (Mitridae 1864).

PILSBRY, Henry A.

1895. *Catalogue of the Marine Mollusks of Japan.* Detroit, pp. i - viii; 1 - 196; pls. 1 - 11.

1921. Marine Mollusks of Hawaii. VIII - XIII. *Proc. Acad. Nat. Sci. Philadelphia* 72: 296 - 328; pl. 12; textfigs.

1922. Revision of W. M. Gabb's Tertiary Mollusca of Santo Domingo. *Proc. Acad. Nat. Sci. Philadelphia.* 73 (2): 305 - 435; pls. 16 - 47.

1944. Molluscan fossils from the Rio Pachitea and vicinity in Eastern Peru. *Proc. Acad. Nat. Sci. Philadelphia* 96: 137 - 153; pls. 9 - 11.

PILSBRY, Henry A. and C. W. JOHNSON

1917. New mollusca of the Santo Domingan Oligocene. *Proc. Acad. Nat. Sci. Philadelphia* 69: 150 - 202.

Pilsbry, Henry A. and T. L. McGinty

1949. New marine mollusks of Florida and the Bahamas. *The Nautilus* 63 (1): 9 - 15; pl. 1.

Pilsbry, Henry A. and A. A. Olsson

1941. A Pliocene fauna from Western Ecuador. *Proc. Acad. Nat. Sci. Philadelphia* 93: 1 - 79; pls. 1 - 19.

Pilsbry, Henry A. and A. Olsson

1954. Systems of the Volutidae. *Bull. Amer. Paleont.* 35 (152): 1 - 36; pls. 1 - 4 (25 - 28).

Ponder, Winston F.

1968. Nomenclatural notes on some New Zealand rachiglossan gastropods with descriptions of five new species. *Rec. Dom. Mus., Wellington* 6 (4): 29 - 47; pls. 1 - 5.

Powell, Arthur William Baden

1934. Gasteropods new to the New Zealand fauna; with descriptions of six new species and a new subspecies. *Trans. Roy. Soc. N.Z.* 64: 154 - 160; pl. 21.

1937. *New species of marine mollusca from New Zealand; in Discovery Reports.* Cambridge University Press, 15: 153 - 222; pls. 45 - 56.

1951. *Antarctic and Subantarctic Mollusca: Pelecypoda and Gastropoda; in Discovery Reports.* Cambridge University Press 26: 47 - 196; pls. 5 - 10.

1952. New Zealand Molluscan Systematics, with descriptions of new species, Part I. *Rec. Auckland Inst. Mus.* 4 (3): 169 - 185; pls. 35 - 36.

1958. *Mollusca from the Victoria-Ross Quadrants of Antarctica. B.A.N.Z. Antarctic Research Expedition* 1929-1931. Canberra, Govt. Printing office, 6 (9): 167 - 209; pls. 1 - 3.

1966. The Molluscan families Speightiidae and Turridae. *Bull Auckland Inst. Mus.* 5: 1 - 184; pls. 1 - 23; textfigs.

Powell, A. W. B. and J. A. Bartrum

1929. The Tertiary (Waitematan) Molluscan fauna of Oneroa, Waiheke Island. *Trans. N.Z. Inst.* 60: 395 - 447; pls. 34 - 50.

Preston, H. B.

1904. Descriptions of some new species of Cingalese and Indian marine shells. *J. Malac.* 11 (4): 75 - 78; pls. 6 - 7.

1908. Descriptions of new species of Land, Marine and Freshwater shells from the Andaman Islands. *Rec. Indian Mus.* 2 (2): 187 - 210; pls. 14 - 17.

1928. *Zoological Record for* 1927. VIII. *Mollusca.* London, 64: 1 - 117.

Pritchard, G. B. and J. H. Gatliff

1899. Catalogue of the marine shells of Victoria. Part II. *Proc. Roy. Soc. Victoria* 11 (2): 185 - 208.

Quoy, Jean René Constant and J. P. Gaimard

1832-1835. *Voyage de découvertes de L'Astrolabe exécuté par ordre du Roi, pendant les années* 1826 - 1828 - 1829, *sous le commandement de M. J. Dumont d'Urville. Zoologie.* Paris, 2 (2): 321 - 686; pls. 25 - 45 bis. (Mitridae: 2 (2): 633 - 660; pls. 45 - 45 bis—1833).

Rafinesque-Schmaltz, C. S.

1815. *Analyse de la nature; ou, tableau de l'universe et des corps organisés.* Palermo, pp. 1 - 224.

Raincourt, M. de

1874. Description d'espèces nouvelles du Bassin de Paris. *Bull. Soc. géol. France* ser. 3, 2: 202 - 205; pl. 6.

Ravn, Jesper Peter Johansen

1933. Études sur les Pélécypodes et Gastropodes Daniens du Calcaire de Faxe. *Kgl. Danske Vid. Selsk. Skrift. Nat. Math.* 5 (2): 1 - 71; pls. 1 - 7.

Ray, H. C.

1954. Miters of Indian waters (Mollusca, Gastropoda: Family Mitridae). *Mem. Indian Mus.* 14 (1): 1 - 72; pls. 1 - 3.

Recluz, M. C.

1853. Description de coquilles nouvelles (Genres *Turbo, Triton* et *Mitra*). *J. Conchyl.* 4: 245 - 249; pls. 7 - 8.

Reeve, Lovell Augustus

1844-1845. *Conchologia iconica: or, illustrations of molluscous animals. Monograph of the genus Mitra.* London, 2: pls. 1 - 39 (pls. 1 - 27: 1844; pls. 28 - 39: 1845).

Rehder, Harald A.

1943. New marine mollusks from the Antillean region. *Proc. U.S. Nat. Mus.* 93: 187 - 203; pls. 19 - 20.

1967. Valid zoological names of the Portland catalogue. *Proc. U.S. Nat. Mus.* 121 (3579): 1 - 51.

RISBEC, Jean

1955. Considérations sur l'anatomie comparée et la classification des Gastéropodes Prosobranches. *J. Conchyl.* 95 (2): 45 - 82; textfigs.

RISSO, Antoine

1826. *Histoire Naturelle des principales productions de L'europe Méridionale et particulièrement de celles des environs de Nice et des Alpes maritimes.* Paris, 4: i - vii; 1 - 439; 12 pls.

ROCHEBRUNE, A. T. de and J. MABILLE

1889. *Mission scientifiques du Cap Horn. Zoologie.* 1882-1883. Paris, 6: 1 - 143; pls. 1 - 9.

RÖDING, Peter Friedrich

1798. *Museum Boltenianum sive Catalogus cimeliorum e tribus regnis naturae. Pars secunda.* Hamburg, pp. i - viii; 1 - 199.

RONCHETTI, C. Rossi

1954. I tipi della "Conchiologia fossile subappenina" di G. Brocchi. *Riv. Italiana Paleont. Strat.* 60 (4): 235 - 250; textfigs.

RUTSCH, R.

1934. Die Gastropoden aus dem Neogen der Punta Gavilan in Nord-Venezuela. *Abh. Schweiz. Palaeont. Gesell.* 54: 1 - 88; pls. 1 - 7.

SACCO, Frederico

1904. *I molluschi dei terreni Terziarii del Piemonte e della Liguria.* Torino, Pt. 30: 1 - 203; pls. 1 - 31.

SAKURAI, Kin'ichi and T. HABE

1964. Descriptions of two new Vexilliid species dedicated to Dr. T. Kuroda's 77th Birthday. *Venus: Jap. J. Malac.* 23 (1): 29 - 33; pl. 2.

SARS, G. O.

1878. *Mollusca regionis Arcticae Norvegiae.* Christiania, 1: 1 - 466; pls. 1 - 34; I - XVIII.

SCHEPMAN, M. M.

1913. *The Prosobranchia of the Siboga Expedition. Part* IV. *Rhachiglossa.* Leiden, Siboga-Expeditie 49d: 247 - 363; pls. 18 - 24.

SCHRÖTER, Johann Samuel

1783-1786. Einleitung in die Conchylienkenntnis nach Linné. Halle, Vols. 1 - 3.

1804. Neue Conchylienarten und Abänderungen, Anmerkungen und Berichtigungen nach dem Linneischen Systems der XII Ausgabe (Fortsetzung). *Arch. Zool. Zootomie* 4 (1): 7 - 44.

SCHUBERT, Heinrich Gotthilf and J. A. WAGNER

1829. *Neues systematisches Conchylien-Cabinet angefangen von Martini und Chemnitz, fortgesetzt von G. H. Schubert und J. A. Wagner.* Nürnberg, 12: i - xii; 1 - 196; pls. 214 - 237.

SCHUMACHER, Chrétien Frédéric

1817. *Essai d'un Nouveau système des habitations des Vers testacés.* Copenhagen, pp. i - iv; 1 - 287; pls. 1 - 22.

SEGUENZA, G.

1880. Le formazioni terziarie nella provincia di Reggio (Calabria). *Atti. Real. Accad. Linc. Roma* ser. 3, 6: 3 - 446; pls. 1 - 17.

SHASKY, Donald R. and G. B. CAMPBELL

1964. New and otherwise interesting species of mollusks from Guaymas, Sonora, Mexico. *The Veliger* 7 (2): 114 - 120; pls. 21 - 22; textfigs.

SHIKAMA, Tokio

1963-1964. *Selected shells of the world illustrated in colours.* Tokyo, 1: 1 - 154; 102 pls.; textfigs. (1963); 2: 1 - 212; 70 pls.; textfigs. (1964).

SHUTO, Tsugio

1962. Buccinacean and Volutacean Gastropods from the Miyazaki Group. *Mem. Fac. Sci. Kyushu Univ.* ser. D, 12 (1): 27 - 85; pls. 6 - 13.

1969. Neogene Gastropods from Panay Island, the Philippines. *Mem. Fac. Sci. Kyushu Univ.* ser. D, 19 (1): 1 - 250; pls. 1 - 24.

SMITH, Burnett

1907. Note on the value of the gastropod apex as a means of classification. *Proc. Acad. Nat. Sci. Philadelphia* 59 (2): 194.

1945. Observations on Gastropod protoconchs. *Palaeont. Americana* 3 (19): 5 - 48; pls. 1 - 3.

1946. Observations on Gastropod protoconchs. *Palaeont. Americana* 3 (21): 5 - 18; pl. 1.

SMITH, Edgar A.

1876. A list of Marine shells chiefly from the Solomon Islands with descriptions of several new species. *J. Linn. Soc. Lond. Zool.* 12: 535 - 562; pl. 30.

1879. On a collection of Mollusca from Japan. *Proc. Zool. Soc. Lond.* 1879: 181 - 218; pls. 19 - 20.

1884. *Report on the Zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "Alert"* 1881-2. London, pp. i - xxv; 1 - 684; pls. 1 - 54.

1890a. Notes on the Zoology of Fernado Noronha. Mollusca. *J. Linn. Soc. Lond. Zool.* 20: 483 - 503; pl. 30.

1890b. Report on the Marine Molluscan Fauna of the Island of St. Helena. *Proc. Zool. Soc. Lond.* 1890: 247 - 317; pls. 21 - 24.

1891. Descriptions of new species of shells from the "Challenger" Expedition. *Proc. Zool. Soc. Lond.* 1891: 436 - 445; pls. 34 - 35.

1894. On some species of shells from New Zealand and Australia, and remarks upon some Atlantic forms occurring in deep water off Sydney. *Proc. Malac. Soc. Lond.* 1 (1): 57 - 60; pl. 7.

1897. Notes on some type-specimens in the British Museum. *Proc. Malac. Soc. Lond.* 2 (5): 229 - 232.

1898. On a small collection of marine shells from New Zealand and Macquarie Island, with descriptions of new species. *Proc. Malac. Soc. Lond.* 3 (1): 20 - 25; textfigs.

1906a. Notes on some species of Mitridae, with the description of *M.brettinghami,* n.sp. *Proc. Malac. Soc. Lond.* 7 (3): 124 - 125.

1906b. On South African Marine Mollusca, with descriptions of new species. *Ann. Natal Govt. Mus.* 1 (1): 19 - 71; pls. 7 - 8.

1915. *British Antarctic ("Terra Nova") Expedition,* 1910. *Natural History Report. Zoology. Mollusca.* London, B.M. Publ. 2 (4): 61 - 112; pls. 1 - 2.

SMITH, Maxwell

1938. Further notes upon Tertiary and Recent Mollusks from Florida, with descriptions of new species. *The Nautilus* 51 (3): 88 - 91; pl. 6.

SOHL, Norman F.

1963. New gastropod genera from the late Upper Cretaceous of the east Gulf Coast plain. *J. Paleont.* 37 (4): 747 - 757; pls. 89 - 90.

1964a. Neogastropoda, Opisthobranchia and Basommatophora from the Ripley, Owl Creek, and Prairie Bluff formations. *U.S. Geol. Surv. Prof. Pap.* 331B: 153 - 344; pls. 19 - 52.

1964b. Gastropods from the Coffee Sand (Upper Cretaceous) of Mississippi. *U.S. Geol. Surv. Prof. Pap.* 331C: 345 - 394; pls. 53 - 57; textfigs.

SORGENFREI, Theodor

1958. *Molluscan assemblages from the marine middle Miocene of South Jutland and their environments.* Copenhagen, Geol. Surv. Denmark, ser. 2, 1: 1 - 355; 2: 356 - 503; pls. 1 - 76; textfigs.

SOUVERBIE, M.

1860. Descriptions d'espèces nouvelles de l'Archipel calédonien. *J. Conchyl.* 8: 311 - 326; pl. 11.

1865. Descriptions d'espèces nouvelles de l'Archipel calédonien. *J. Conchyl.* 13: 150 - 159; pl. 5.

1871. Descriptions d'espèces provenant de la Nouvelle-Calédonie. *J. Conchyl.* 19: 334 - 335.

1875a. Descriptions d'espèces nouvelles de l'Archipel Calédonien. *J. Conchyl.* 23: 33 - 44; pl. 4.

1875b. Descriptions d'espèces nouvelles de l'Archipel Calédonien. *J. Conchyl.* 23: 282 - 297; pl. 13.

1876. Descriptions d'espèces nouvelles de l'Archipel Calédonien. *J. Conchyl.* 24: 376 - 381; pl. 13.

SOUVERBIE, M. and R. P. MONTROUZIER

1862. Descriptions d'espèces nouvelles de l'Archipel calédonien. *J. Conchyl.* 10: 231 - 248.

SOWERBY, George Brettingam (first of name)

1825. *A Catalogue of the Shells contained in the collection of the late Earl of Tankerville.* London, pp. i - vii; 1 - 92; App. pp. i - xxxiv; 9 pls.

SOWERBY, George Brettingham (second of name)

1842. *A conchological manual.* London, ed. 2.; pp. i - vi; 1 - 313; pls. 1 - 27.

1850. Descriptions of new species of fossil shells found by J. S. Heniker. *Quart. J. Geol. Soc. Lond.* 6: 44 - 53; pls. 9 - 10.

SOWERBY, George Brettingham (second and third of name)

1870. Descriptions of forty-eight new species of shells. *Proc. Zool. Soc. Lond.* 1870: 249 - 259; pls. 21 - 22.

1874. *Thesaurus Conchyliorum. Monograph of the genus Mitra.* London, 4: 1 - 46; pls. 1 - 28.

1875. Descriptions of ten new species of shells. *Proc. Zool. Soc. Lond.* 1875: 125 - 129; pl. 24.

1879. Descriptions of ten new species of shells. *Proc. Zool. Soc. Lond.* 1878: 795 - 798; pl. 48.

1882. Descriptions of new species of shells in the collection of Mr. J. Cosmo Melvill. *Proc. Zool. Soc. Lond.* 1882: 117 - 121; pl. 5.

SOWERBY, George Brettingham (third of name)

1887. *Thesaurus Conchyliorum; second Supplement to monograph of the genus Voluta.* London, 5: 297 - 305; pls. 14 - 18.

1889a. Descriptions of fourteen new species of shells from China, Japan, and the Andaman Islands, chiefly collected by Deputy Surgeon-Gen. R. Hungerford. *Proc. Zool. Soc. Lond.* 1888: 565 - 570; pl. 28.

1889b. Some further notes on marine shells collected at Port Elizabeth, South Africa, with descriptions of some new species. *J. Conch.* 6: 6 - 15; pl. 1.

1889c. Descriptions of fourteen new species of shells. *J. Linn. Soc. Lond. Zool.* 20 (123): 395 - 400; pl. 25.

1892. *Marine shells of South Africa.* London, pp. i - iv; 1 - 89; pls. 1 - 5.

1897. *Appendix to Marine shells of South Africa.* London, pp. 1 - 42; pls. 6 - 8.

1900a. On some marine shells from Pondoland and the Kowie, with descriptions of seventeen new species. *Proc. Malac. Soc. Lond.* 4 (1): 1 - 7; pl. 1.

1900b. Descriptions of new species of marine Mollusca collected by the late Otto Koch at the Island of Cebú, Philippines. *Proc. Malac. Soc. Lond.* 4 (3): 126 - 129; pl. 11.

1901. On seven new species of marine mollusca collected by Dr. H. Becker at "The Kowie", South Africa. *Proc. Malac. Soc. Lond.* 4 (5): 213 - 215; pl. 22.

1907. Descriptions of new marine Mollusca from New Caledonia, etc. *Proc. Malac. Soc. Lond.* 7 (5): 299 - 303; pl. 25.

1908. *Mitra recurvirostris*; name substituted for *M.recurva,* Sowerby. *Proc. Malac. Soc. Lond.* 8 (1): 4.

1913. Descriptions of new species of Mollusca. *Ann. Mag. Nat. Hist.* (8) 12: 233 - 239; pl. 3.

1914. Descriptions of new Mollusca from New Caledonia, Japan, Philippines, China and West Africa. *Ann. Mag. Nat. Hist.* (8) 14 (84): 475 - 480; pl. 19.

1916. Descriptions of two new Mollusca of the genera *Leptothyra* and *Mitra. Ann. Mag. Nat. Hist.* (8) 18: 491 - 492; textfigs.

Sowerby, James

1823. *The Mineral Conchology of Great Britain.* London, 4: 1 - 148; pls. 307 - 406.

1825. *The Mineral Conchology of Great Britain.* London, 5: 1 - 168; pls. 408 - 503.

Sowerby, James and G. B. Sowerby

1828. *The genera of Recent and Fossil shells, for the use of students in Conchology and Geology.* London, pt. 31; pl. 250, fig. 4.

Speyer, Oscar

1862. Die Conchylien der Casseler Tertiär-Bildungen. *Palaeontographica* 9: 91 - 141; pls. 18 - 22.

Spiion, Gale G.

1961. Notes on the Mitridae of the Eastern Pacific. I.—*Mitra fultoni* E. A. Smith. *The Veliger* 4 (1): 32 - 36; pl. 7.

1969. Notes on the Mitridae of the Eastern Pacific II. The genus *Thala,* with description of a new species. *The Veliger* 12 (1): 84 - 88; pl. 6; textfigs.

Spry, J. F.

1961. The sea shells of Dar es Salaam. *Tanganyika Not. Rec.* No. 56: 1 - 33; pls. 1 - 8.

Stanton, Timothy W.

1920. The fauna of the Cannonball marine member of the Lance formation. *U.S. Geol. Surv. Prof. Pap.* 128A: 1 - 60; pls. 1 - 9.

Stenzel, H. B. and F. E. Turner

1940. The Gastropod genera *Cryptochorda* and *Lapparia* in the Eocene of the Gulf Coastal Plain and Turritellidae from the Paleocene and Eocene of the Gulf Coast. *Univ. Texas Publ.* No. 3945: 795 - 846; pls. 43 - 47.

Stephenson, Lloyd William.

1952. Larger Invertebrate fossils of the Woodbine formation (Cenomanian) of Texas. *U.S. Geol. Surv. Prof. Pap.* 242: 1 - 226; pls. 8 - 59.

Stewart, Ralph B.

1927. Gabb's California fossil type Gastropods. *Proc. Acad. Nat. Sci. Philadelphia* 78: 287 - 447; pls. 20 - 32.

Stoliczka, Ferdinand

1868. Gastropoda of the Cretaceous rocks of Southern India. *Mem. Geol. Surv. India, Paleont. Indica* 2: i - xiii; 1 - 497; pls. 1 - 28.

Stoll, Norman Rudolph *et al.*

1964. *International Code of Zoological Nomenclature adopted by the* XV. *International Congress of Zoology.* London, pp. i - xvii; 1 - 176.

Strebel, Hermann

1908. *Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition* 1901-1903. *Die Gastropoden.* Stockholm, 6 (1): 1 - 111; pls. 1 - 6.

STRONG, A. M., G. D. HANNA and L. G. HERTLEIN

1933. Marine Mollusca from Acapulco, Mexico, with notes on other species. *Proc. California Acad. Sci.* ser. 4. 21 (10): 117 - 130; pls. 5 - 6.

STURANY, Rudolf

1903. *Expeditionen S.M. Schiff "Pola" in das Rothe Meer Nördliche und Südliche Hälfte* 1895/96 - 1897/98. *Zool. Ergebnisse, Gastropoden.* Wien, 23: 1 - 75; pls. 1 - 7.

SUTER, Henry

1897. Note on *Mitra obscura*, Hutton. *Proc. Malac. Soc. Lond.* 2 (5): 201 - 202; textfig.

1908. Result of dredging for Mollusca near Cuvier Island, with descriptions of new species. *Trans. N.Z. Inst.* 40: 344 - 359; pls. 26 - 27, 30.

1909a. Scientific results of the New Zealand Government Trawling Expedition, 1907. *Rec. Canterbury Mus.* 1 (2): 1 - 14; pl. 12.

1909b. Mollusca: Part I.—Amphineura, Gastropoda, and Scaphopoda. *Rec. Canterbury Mus.* 1 (2): 117 - 130; pl. 12.

1913-1915. *Manual of the New Zealand Mollusca; with an Atlas of quarto plates.* Wellington, pp. i - xxiii; 1 - 1120 (text—1913); pls. 1 - 72 (Atlas—1915).

1915. Revision of the Tertiary Mollusca of New Zealand, based on type material. Part II. *N.Z. Geol. Surv. Palaeont. Bull.* 3: 1 - 69; pls. 1 - 9.

1917. Descriptions of new Tertiary Mollusca occurring in New Zealand, accompanied by a few notes on necessary changes in Nomenclature. Part I. *N.Z. Geol. Surv. Palaeont. Bull.* 5: 1 - 93; pls. 1 - 13.

SWAINSON, William

1820-1833. *Zoological Illustrations, or original figures and descriptions of new, rare, or interesting animals.* London, ser. 1, Vols. 1 - 3, 182 pls. (1820-1823); ser. 2, Vols. 1 - 3, 136 pls. (1829-1833).

1821. *Exotic Conchology or figures and descriptions of rare, beautiful or undescribed shells.* London, pt. 3; unnumbered plates.

1822. *A catalogue of the rare and valuable shells, which formed the celebrated collection of the late Mrs. Bligh.* London, pp. 1 - 58; App. pp. 1 - 20; 2 pls.

1823. The characters of several rare and undescribed shells. *Phil. Mag. & J.* 61: 375 - 378.

1824. The characters of several new shells, belonging to the Linnaean Volutae, with a few observations on the present state of Conchology. *Quart. J. Sci. Lit. Arts* 17 (33): 28 - 38.

1840. *A treatise on malacology or the natural classification of shells and shell-fish.* London, pp. i - viii; 1 - 419; textfigs.

SYKES, E. R.

1911. On the mollusca procured during the "Porcupine" Expeditions, 1869-70. Supplemental notes, Part IV. *Proc. Malac. Soc. Lond.* 9 (6): 331 - 348; textfigs.

1912. Note on *Aphanitoma locardi*, Bavay, and *Mitra biconica*, Sykes. *Proc. Malac. Soc. Lon.* 10 (1): 4.

TAKI, Isao and K. OYAMA

1954. Matajiro Yokoyama's The Pliocene and later faunas from the Kwanto region in Japan. *Palaeont. Soc. Japan Spec. Pap.* No. 2: 1 - 68; pls. 1 - 49.

TAPPARONE-CANEFRI, Cesare

1874. *Zoologia del viaggio intorno al globo della fregata Magenta durante gli anni* 1865-68. Torino, pp. 1 - 161; pls. 1 - 4.

TATE, Ralph

1887. Descriptions of some new species of South Australian marine and Fresh-water Mollusca. *Trans. Roy. Soc. Sth. Australia* 9: 62 - 75; pls. 4 - 5.

1889. The gastropods of the Older Tertiary of Australia. (Part II). *Trans. Roy. Soc. Sth. Australia* 11: 116 - 174; pls. 2 - 10.

1899. On some older Tertiary fossils of uncertain age from the Murray Desert. *Trans. Roy. Soc. Sth. Australia* 23: 102 - 111; pl. 1.

TAYLOR, D. W. and N. F. SOHL

1962. An outline of Gastropod classification. *Malacologia* 1 (1): 7 - 32.

TENISON-WOODS, J. E.

1876. Descriptions of new Tasmanian shells. *Proc. Roy. Soc. Tasmania* pp. 2 - 30 (in reprint).

1877. On some new Tasmanian marine shells. *Proc. Roy. Soc. Tasmania* pp. 131 - 159.

1878. Census; with brief descriptions of the marine shells of Tasmania and the adjacent Islands. *Proc. Roy. Soc. Tasmania* pp. 3 - 34 (in reprint).

1879. On some new Tasmanian marine shells. *Proc. Roy. Soc. Tasmania* pp. 32 - 40.

1880. On some Tertiary fossils. *Proc. Linn. Soc. N.S.W.* 4 (1): 1 - 26; pls. 1 - 4.

TESCH, P.

1915-1920. *Jungtertiäre und Quartäre Mollusken von Timor.* Paläontologie von Timor, 5 (9): 1 - 134, pls. 73 - 95 (1915); 8 (14): 41 - 125, pls. 128 - 140 (1920).

THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

1968. Opinion 841. *Voluta pertusa* Linnaeus, 1758, *Voluta morio* Linnaeus, 1767, *Voluta ruffina*. Linnaeus, 1767, and *Bulla conoidea* Linnaeus, 1767: suppressed under the plenary powers. *Bull. zool. Nomencl.* 24 (6): 341 - 343.

1969. Opinion 885. *Voluta mitra* Linnaeus, 1758 (Mollusca: Gastropoda): added to the Official List. *Bull. zool. Nomencl.* 26 (3): 125 - 127.

THIELE, Johannes

1912. *Deutsche Südpolar-Expedition* 1901-1903. *Die Antarktischen Schnecken und Muscheln*. Berlin, 13 (5): 185 - 285; pls. 11 - 16.

1925. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia"* 1898-1899. *Gastropoda*. II. *Teil*. Jena, 17 (2): 1 - 348; pls. 1 - 34 (13 - 46).

1929. *Handbuch der systematischen Weichtierkunde*. Jena, pp. 1 - 1154; textfigs.

TINKER, Spencer Wilkie

1958. *Pacific Sea shells*. Rutland & Tokyo, pp. 1 - 240; 99 pls.

TOLDO, Giovanni

1889. Mitridae del Miocene superiore di Montegibio. *Bull. Soc. Malac. Ital.* 14: 144 - 150; pl. 3.

TOMLIN, John Read le B.

1920. On certain of Link's names in the Mitridae. *The Nautilus* 33 (4): 133 - 134.

1932. Reports on the marine Mollusca in the collection of the South African Museum. VI - VIII. *Ann. Sth. African Mus.* 30 (2): 157 - 169; textfigs.

1943. New species of *Charitodoron*. *J. Conch.* 22 (3): 50; textfig.

TOMLIN, J. R. le B. and A. E. SALISBURY

1928. Laborde's "Voyage" and the Mollusca therein described by Deshayes. *Proc. Malac. Soc. Lond.* 18 (1): 32 - 35; pl. 1.

TOMLIN, J. R. le B. and R. WINKWORTH

1936. An Index to the species of Mollusca in the Beschreibung of H. F. Link. *Proc. Malac. Soc. Lond.* 22 (1): 27 - 48.

TOULA, Franz

1911a. Nachträge zur jungtertiären (pliocänen) Fauna von Tehuantepec. *Jahrb. k. k. geol. Reichsanst.* 61: 473 - 486.

1911b. Die jungtertiäre Fauna von Gatun am Panama-Kanal; pt. 2. *Jahrb. k. k. geol. Reichsanst.* 61: 487 - 530; pls. 30 - 31.

TRECHMANN, C. T.

1925. The Scotland beds of Barbados. *Geol. Magazine* 62: 481 - 504.

TROSCHEL, Franz Hermann

1856-1893. *Das Gebiss der Schnecken zur Begründung einer natürlichen Classification*. Berlin, 1: i - viii; 1 - 252; pls. 1 - 20; 2: i - ix; 1 - 407; pls. 1 - 32 (Mitridae pp. 58; 66 - 69; 86; 102 - 104; pls. 5 - 6; 8 - 9—1866-69).

TRYON, George W.

1882. *Manual of Conchology, Structural and Systematic; with Illustrations of the species*. Vol. 4, *Nassidae, Turbinellidae, Volutidae, Mitridae*. Philadelphia, Mitridae: pp. 106 - 276; pls. 2, 32 - 58.

TURNER, Ruth D.

1956a. The Eastern Pacific Mollusks described by C. B. Adams. *Occ. Pap. Moll. Harvard* 2 (20): 21 - 135; pls. 5 - 20.

1956b. Additions to the Western Atlantic Marine Mollusks described by C. B. Adams. *Occ. Pap. Moll. Harvard* 2 (20): 136; pl. 21.

TURTON, W. H.

1932. *The Marine shells of Port Alfred S. Africa*. London, pp. i - xvi; 1 - 331; pls. 1 - 70.

1933. The Marine shells of Port Alfred. S. Africa. *J. Conch.* 19 (11): 370 - 371.

VAYSSIERE, Albert Jean Baptiste Marie

1901. Étude zoologique et anatomique de la *Mitra zonata* Marryatt. *J. Conchyl.* 49: 77 - 95; pl. 3.

VELLA, Paul

1954. Tertiary Mollusca from South-east Wairapa. *Trans. Roy. Soc. N.Z.* 81 (4): 539 - 555; pls. 25 - 27.

VERCO, John

1896. Descriptions of new species of marine Mollusca of South Australia. *Trans. Roy. Soc. Sth. Australia* 20: 217 - 232; pls. 6 - 8.

1908. *Catalogue of marine Mollusca of South Australia*. Adelaide, pp. 1 - 24.

1909. Notes on South Australian marine Mollusca, with descriptions of new species.— Part XII. *Trans Roy. Soc. Sth. Australia* 33: 293 - 342; pls. 26 - 29.

VLERK, I. M. van der

1931. Feestbundel Prof. Dr. K. Martin 1851-1931. Caenozoic Amphineura, Gastropoda, Lamellibranchiata, Scaphopoda. *Leidsche Geol. Meded.* 5: 206 - 296.

VOKES, Harold Ernest

1939. Molluscan faunas of the Domengine and Arroyo Hondo formations of the California Eocene. *Ann. New York Acad. Sci.* 38: 1 - 246; pls. 1 - 22.

VREDENBURG, E.

1923. Indian Tertiary Gastropoda, IV. Olividae, Harpidae, Marginellidae, Volutidae, and Mitridae, with comparative diagnoses of new species. *Rec. Geol. Surv. India* 54 (3): 243 - 276; pls. 14 - 16.

1925. Descriptions of Mollusca from Post-Eocene Tertiary formation of North-Western India: Cephalopoda, Opisthobranchiata, Siphonostomata. *Mem. Geol. Surv. India* 1 (1): 1 - 325; pls. 1 - 13.

WADE, Bruce

1926. The fauna of the Ripley formation on Coon Creek, Tennessee. *U.S. Geol. Surv. Prof. Pap.* 137: 1 - 272; pls. 1 - 72.

WATSON, R. Boog

1876. Notes on Lowe's MS list of Webb's type shells from the Canaries (1829), and on the annotations thereon of D'Orbigny (1839), and Lowe (1860). *J. Linn. Soc. Lond.* 12: 516 - 524.

1882. Mollusca of H.M.S. "Challenger" Expedition.— Part XII. *J. Linn. Soc. Lond. Zool.* 16 (93): 324 - 343.

1886. *Report on the scientific results of the voyage of H.M.S. Challenger during the years* 1873-76. London, 15: i - v; 1 - 756; pls. 1 - 50; 1 - 3.

WEBB, J. H.

1958. A new *Mitra* from Japan. *Venus: Jap. J. Malac.* 20 (1): 30 - 31; textfigs.

WEISBORD, N. E.

1929. Miocene Mollusca of northern Columbia. *Bull. Americ. Paleont.* 14 (54): 235 - 310; pls. 1 - 9.

WENZ, Wilhelm

1943. *Handbuch der Paläozoologie. Allgemeiner Teil und Prosobranchia.* Berlin, 6 (1): 1201 - 1506; textfigs.

WILLIAMSON, M. Burton

1906. West American Mitridae—North of Cape St. Lucas, Lower California. *Proc. Biol. Soc. Washington* 19: 193 - 198.

WILSON, Druid

1948. Notes on *Perplicaria* Dall and its systematic position. *The Nautilus* 61 (4): 112 - 114.

WINKWORTH, Ronald

1945. The types of the Boltenian genera. *Proc. Malac. Soc. Lond.* 26 (4/5): 136 - 148.

WOLFSON, Fay H.

1969. Spawning Notes, II.— *Mitra dolorosa*. *The Veliger* 11 (3): 282 - 283; textfigs.

WOOD, William

1825. *Index Testaceologicus; or a catalogue of shells British and Foreign, arranged according to the Linnean system*. London, pp. i - xxxii; 1 - 188; pls. 1 - 38.

1828. *Supplement to the Index Testaceologicus; or a catalogue of shells, British and Foreign.* London, pp. i - iv; 1 - 59; pls. 1 - 8.

WOODRING, Wendell Phillips

1928. Miocene mollusks from Bowden, Jamaica: Part II: Gastropods and discussion of results. *Carnegie Inst. Washington Publ.* No. 385: 1 - 564; pls. 1 - 40; textfigs.

1964. Geology and Paleontology of Canal Zone and adjoining parts of Panama. Description of Tertiary Mollusks (Gastropods: Columbellidae to Volutidae). *U.S. Geol. Surv. Prof. Pap.* No. 306C: 241 - 297; pls. 39 - 47.

1966. The Panama land bridge as a Sea barrier. *Proc. Amer. Phil. Soc.* 110 (6): 425 - 433: textfigs.

YOKOYAMA, M.

1920. Fossils from the Miura Peninsula and its immediate north. *Tokyo Imp. Univ. Coll. Sci. J.* 39 (6): 1 - 193; pls. 1 - 20.

1923. Tertiary Mollusca from Dainichi in Totomi. *Tokyo Imp. Univ. Coll. Sci. J.* 45 (2): 1 - 18; pls. 1 - 2.

1928. Pliocene shells from Hyuga. *J. Fac. Sci. Imp. Univ. Tokyo* 2 (7): 331 - 350; pls. 66 - 67.

ZEKELI, L. Friedrich

1852. Die Gasteropoden der Gosaugebilde in den Nordöstlichen Alpen. *Abh. k. k. geol. Reichsanst.* 1 (2): 1 - 124; pls. 1 - 24.

ZILCH, Adolf

1934. Zur Fauna des Mittel-Miocäns von Kostej (Banat). Typus-Bestimmung und Tafeln zu O. Boettger's Bearbeitungen. *Senckenbergiana* 16 (4/6): 193 - 302; pls. 1 - 22.

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